Governance in the Blockchain Economy:

A Framework and Research Agenda

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Abstract

Blockchain technology is often referred to as a groundbreaking innovation and the harbinger of a new economic era. Blockchain might engender a new type of economic system, the blockchain economy. In the blockchain economy, agreed-upon transactions would be enforced autonomously following rules defined by smart contracts. The blockchain economy would manifest itself in a new form of organizational design—decentralized autonomous organizations (DAO)—which are organizations with governance rules specified in the blockchain. We discuss the blockchain economy along dimensions defined in the IT governance literature: decision rights, accountability, and incentives. Our case study of a DAO illustrates that governance in the blockchain economy might radically depart from established notions of governance. Using the three governance dimensions, we propose a novel IT governance framework and a research agenda for governance in the blockchain economy. We challenge common assumptions in the blockchain discourse, and propose promising information systems research related to those assumptions.

1. Introduction

Some argue that the blockchain economy is emerging, requiring new governance approaches (Niederman et al., 2017). We illustrate this blockchain economy and explore the case of an emerging decentralized autonomous organization (DAO) to explore decision rights, accountability, and incentives related to governance (Weill, 2004). Building on Weill's work, we provide a novel IT governance framework and a research agenda to examine changes to governance that may accompany the emergence of the blockchain economy. A recent paper suggests a practical research agenda for studying blockchain (Risius & Spohrer, 2017). Our effort is aimed at theorizing in information systems (IS) research, and challenging implicit assumptions from the blockchain discourse. We shed light on some "dark" issues of blockchain, and identify important avenues for research concerning governance in the blockchain economy.

Blockchain can be described as a decentralized, transactional database technology that facilitates validated, tamper-resistant transactions consistent across a large number of network participants called nodes (Glaser, 2017). Blockchain is a class of technologies (sometimes called distributed ledger technologies) that give users confidence that archived

information (e.g., a certificate) has not been tampered with. In principle, this guarantees a "single truth" across different agents who may or may not trust each other. Not surprisingly, financial services has been one of the first industries to express an interest in blockchain (Beck & Müller-Bloch, 2017; Walsh et al., 2016). For centuries, the financial industry has relied on double-entry bookkeeping as a trustworthy method of determining "who owns what" and "who owes whom." In addition to financial services, however, blockchain technology has also been explored in other industries, for instance, as a means of reducing uncertainty in supply chains (Nærland, Müller-Bloch, Beck, & Palmund, 2017), fostering environmental sustainability (Chapron, 2017), and preventing fraudulent tax returns (Hyvärinen, Risius, & Friis, 2017).

Recently, academia has also expressed interest in blockchain (Beck, Avital, Rossi, & Thatcher, 2017; Tapscott & Tapscott, 2016). Thus far, most academic research has focused on cryptocurrencies like Bitcoin (e.g., Böhme, Christin, Edelman, & Moore, 2015; Kazan, Tan, & Lim, 2015; Li & Wang, 2017; Nakamoto, 2008); however, blockchain has since evolved beyond Bitcoin. The release of the freely programmable Ethereum blockchain in 2014 enabled smart contracts, software code that runs exactly as programmed without risk of downtime, censorship, or fraud (Buterin, 2014).

Smart contracts facilitate many different kinds of transactions, going far beyond cryptocurrency transfer.

Little is known about the implications of blockchain for the governance of economic activities. Blockchain and the smart contracts it enables could give rise to a new type of economic system, which we refer to here as the blockchain economy. While the digital economy, where "goods and services traded are in digital format" (Kim, Barua, & Whinston, 2002), has become omnipresent (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013), the blockchain economy extends beyond the digital economy in that agreed-upon transactions are autonomously enforced, following rules defined in smart contracts. The blockchain economy might enable new organizational designs in form of DAOs, autonomous entities using governance rules that conform to the business logic of the blockchain (Jentzsch, n.d.). Established notions of governance are challenged in the blockchain economy. Comparing the blockchain economy to the digital economy we provide a research framework and agenda for governance in the blockchain economy.

2. Literature Background

For purposes of this analysis, we consider blockchain to be a

foundational technology for the blockchain economy. The theoretical foundations for this paper are drawn from the relevant IT governance literature. In this section we discuss the foundations of the blockchain technology, introduce the idea of the blockchain economy, and discuss the issue of governance.

2.1. Blockchain Foundations

Whatever the future of blockchain may be, at this point it is widely assumed to be highly important. Some researchers describe it as being as important as the Internet due to its attendant impacts on business and society (e.g., Beck, 2018). Research suggests that blockchain has the capacity to reduce uncertainty, insecurity, and ambiguity in transactions by providing full transactional disclosure and producing a single truth for all network participants (Beck, Czepluch, Lollike, & Malone, 2016; Nærland et al., 2017).

Technically, a blockchain is a tamper-resistant, decentralized database of transactions consistent across a base of decentralized nodes (Glaser, 2017). It is cryptographically armored against retrospective manipulations, and uses a consensus mechanism to ensure database

consistency whenever new transactions are validated. All transactions saved on the blockchain are stored in blocks; transaction data are stored within the blocks in a cryptographic data structure, the most common being Merkle trees. In Merkle trees, transactions are hashed and repeatedly paired, merged, and rehashed until only one hash remains, the Merkle root. Each block saves the Merkle root of the previous block. This creates a chain of data that are cryptographically secured and linked. Any retrospective attempt to change a transaction necessitates rehashing not only the block that contains the transaction, but all subsequent blocks as well. While this is theoretically possible, it is highly implausible, since other nodes are constantly adding new blocks to the ever-expanding blockchain (Underwood, 2016). Consensus mechanisms encourage the nodes to validate new transactions and discourage them from creating alternative histories of transactions. These consensus mechanisms often employ economic incentives to keep the database consistent. The most common consensus mechanisms are proof-of-work and proof-of-stake. Proof-of-work requires solving a computationally expensive cryptographic puzzle. The node that first finds the solution to the puzzle validates the next block, and is remunerated with cryptocurrency. In proof-of-stake, nodes with more cryptocurrency (larger stakes) have higher probabilities of being chosen to validate the next block. The stake may be destroyed if the node behaves maliciously, which

thus discourages such behavior (see also Tschorsch & Scheuermann, 2016).

The ability to read blockchain data and submit new transactions is determined by access to transactions. Public blockchains allow all nodes to read blockchain data and propose new transactions, whereas private blockchains allow only nodes that are preregistered by a central authority to read blockchain data and submit new transactions (see Table 1). Public blockchains offer either permissioned or permissionless access to transaction validation. In permissionless blockchains, all nodes can validate transactions, while in permissioned blockchains, only nodes that have been preregistered can validate transactions (Peters & Panayi, 2016).

Table 1. Blockchain Typology		
Access to Transactions	**Access to Transaction Validation**	
	Permissioned	Permissionless
Public	All nodes can read and submit transactions. Only authorized nodes can validate transactions.	All nodes can read, submit, and validate transactions.
Private	Only authorized nodes can read, submit, and validate transactions.	Not applicable

2.2. The Blockchain Economy

The first blockchain enabled only the transfer of digital tokens, in this

case the cryptocurrency Bitcoin, and was not used for other more

sophisticated transactions. The launch of Ethereum showed it was possible

to program blockchains to support many kinds of transactional logics through

smart contracts that execute precoded pieces of software on the blockchain

when specific conditions are met (Buterin, 2014). Smart contracts can

execute transactions autonomously, without interference from agents or the

need for approval from third parties. They can be embedded into digital

assets or into the digital representation of physical assets in the form of

tokens that enforce autonomous contract fulfillment (Szabo, 1994). For

instance, through smart contracts, it might become possible to autonomously

and remotely lock a leased car if the owner failed to fulfill leasing obligations.

The blockchain ensures that contracts are fulfilled and not corrupted.

For our purposes, we presume that smart contracts will precipitate the

blockchain economy, a new type of economic system where agreed-upon

transactions can be enforced autonomously according to rules defined in the

contracts. The blockchain economy could potentially facilitate machine-to-

machine coordination within the Internet of things (e.g., Christidis &

Devetsikiotis, 2016; Zhang & Wen, 2017), or the creation of decentralized

electronic marketplaces (e.g., Subramanian, 2018; Wörner, von Bomhard,

Schreier, & Bilgeri, 2016). The blockchain economy would manifest itself in

new forms of organizations called DAOs, in which governance might be decentralized in contrast to the governance of organizations common today (e.g., Swan, 2015; Wright & De Filippi, 2015). The blockchain economy idea is based on a new kind of governance.

2.3. Governance

We use the theoretical perspective of IT governance, a topic of interest for several decades (see Brown & Grant, 2005, for an overview). Weill (2004, p. 3) says, *"IT governance represents the framework for decision rights and accountabilities to encourage desirable behavior in the use of IT"*. Weill's definition invokes three key dimensions of IT governance: decision rights, accountability, and incentives.

Decision rights concern the rights governing control over certain assets. Fama and Jensen (1983) describe two types of decision rights. *Decision management rights* allow generating decision proposals, and executing or implementing decisions. *Decision control rights* allow ratification of decisions (deciding whether decisions are to be implemented) and monitoring decisions (measuring performance of decision agents). Decision rights, in general, determine the *degree of centralization*, that is, whether decision-making power is concentrated in a single person or small group

(centralized), or dispersed (decentralized) (King, 1983; Sambamurthy & Zmud, 1999).

The right to monitor decisions is linked to *accountability*. To be called 'to account' for one's actions is the core sense of this (Mulgan, 2000), but is only one part of an accountability relationship. Agents providing an account must address actions taken and consequences incurred. Enforcement mechanisms are crucial (Burritt & Welch, 1997); decision management rights are often separated from decision control rights to avoid self-monitoring, self-reward, and self-punishment (Moldoveanu & Martin, 2001). Accountability is *enacted*, specified and brought into force, through contracts and legal frameworks governed by institutions, but it can also be enacted through IT infrastructures (Weitzner et al., 2008)—an important consideration for blockchain.

Incentives are underemphasized in Weill's discussion, but have been recognized as central to IS design (Ba, Stallaert, & Whinston, 2001). Incentives motivate agents to act. Jensen and Meckling (1976) address two types of incentives: Pecuniary incentives relate observable agent behavior to monetary reward (or reward that can be monetized). Non-pecuniary incentives relate observable agent behaviour to non-monetary reward, such

as privileges, visibility, or reputation. *Incentive alignment* occurs "when the system's embedded features induce users to employ the system consistent with the design objective" (Ba, Stallaert, & Whinston, 2001, p. 227). A system with aligned incentives makes agents free to choose their own behaviour but inclined to choose actions that coincide with goals of the system's design.

These governance dimensions are anchored in agency theory or principal-agent theory (Moldoveanu & Martin, 2001), in which one party (the principal) delegates work to another party (the agent). The objective is to resolve problems in cases where principals and agents have conflicting desires, goals, or attitudes toward risk (Akerlof, 1970; Eisenhardt, 1989; Jensen & Meckling, 1976). Agency theory is a lens to view allocation of decision rights, to determine how parties are to be held accountable, and how incentives can be used to overcome diverging goals (Fama & Jensen, 1983). While these theoretical perspectives are common to both economics and political science, the analysis here takes primarily an economics perspective.

3. The Swarm City Case

In order to explore governance issues we analyzed a blockchain case.

Swarm City[1] developed out of its predecessor, Arcade City, and was founded in 2017 as a loosely coupled network of software engineers working on the development of an Ethereum-based blockchain application to empower sharing economy platforms. Swarm City is an entrepreneurial network of like-minded developers seeking to disrupt the sharing economy and the platforms that act as central authorities and create markets to facilitate transactions. In today's sharing economy, platform owners are remunerated for providing services, typically through a transaction fee. Their business models have been criticized for exploitative labor practices, and strong network effects have made some sharing economy platforms quasi-monopolistic organizations that capture monopoly rents (The Economist, 2014). These quasi-monopolies are a concern for regulators and politicians alike.

Swarm City seeks to provide a blockchain application for the sharing economy that facilitates building disintermediated sharing economy platforms. Developers can customize the design of sharing economy platforms by choosing application areas (e.g., ride sharing) or by defining governance rules (e.g., whether or not transaction fees are charged). Swarm City envisions developing a market for blockchain-based sharing economy platforms, where different types of platforms compete with each other. As

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[1] https://swarm.city/

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such, Swarm City serves as an example of how blockchain might engender

the blockchain economy and challenges our understanding of IT governance.

Since there was no well-defined company or location where we could

conduct interviews or harvest secondary data, our data collection followed an

unconventional approach. Our collected data include the original Arcade City

white paper, as well as posts from the Swarm City blog (press.swarm.city).

We conducted five interviews with Swarm City developers between

December 2016 and February 2017, and three additional interviews in

February 2018. Each interview was open-ended and semistructured, lasting

40-90 minutes, with an average duration of slightly over 60 minutes. Data

sampling aligned with preconceptions about challenges in blockchain

governance, but was open to allow for new theoretical insights (Urquhart,

Lehmann, & Myers, 2010). We gathered more than 110 pages of interview

transcriptions plus secondary data (see Table 2).

Table 2. Data Collection	
Type of Data	**Number of Pages**
Interviews (8 interviews with 8 individuals associated with Swarm City: business leader, principal cofounder, cofounder, system architect, software engineer, liaison officer, communication officer, member of advisory board)	111
Swarm City blog posts (49 blog posts from press.swarm.city)	215
Arcade City (predecessor of Swarm City) white paper	17
Total	343

We formulated the problem (Van de Ven, 2007), designed the case study (Yin, 2000), and engaged in data collection and analysis. This led to theoretical insights using a pluralistic strategy (Mingers, 2001). The work was inspired by Mingers' (2004) recommendation of pragmatics. We embraced different research perspectives to construct "a useful model of reality" (Van de Ven, 2007), and followed the principle of emergence from grounded theory of fitting insights to the data under study (Glaser & Strauss, 2008). By employing such techniques we increased theoretical scope and conceptualization, treating literature about governance as additional data points for analysis (Urquhart et al., 2010). Our background of blockchain workshops, panels, and events informed the work.

3.1. Decision Rights

Unlike Airbnb or Uber, the ownership of Swarm City is ostensibly organized in a decentralized fashion. However, this form of ownership is limited to decision rights and does not include additional property rights, since anyone can copy the code that instantiates Swarm City and use it. According to a Swarm City business leader: *"There is no real ownership. . . . If anybody wants to copy the code and create his own project from this, he can do this."*

Swarm City developers intend to make the code (and the application itself) increasingly decentralized and autonomous once it is implemented. However, in its current developmental stage, decision rights are highly centralized in what Swarm City developers consider a necessary "benevolent dictatorship." They say initial "centrality" is a prerequisite for "decentrality" later. As a system architect explained:

> *"The first governance structure you might say is something like a dictatorship. . . . The reason we do this is because we believe that for building [Swarm City] as a tool, you [need] a military style way. . . . What we are trying to build is of course a totally decentralized open platform, that is open source and anyone can use, can add value to. But in order to make the tools, we need to do the governance in a really hierarchical way."*

However, the Swarm City development team does plan to relinquish control once initial development is complete. As a business leader explained:

"Our goal is to go from centralized governance to decentralized governance over the period of time. That's something that is totally on our roadmap . . . , for [us who] are deciding now to become obsolete so we don't . . . have that kind of control, that kind of decision-making power for eternity in Swarm City. The aim would be that all the people using Swarm City . . . have a decentralized way of managing it."

Swarm city developers did express some concern about the allocation of decision rights. In the future, token owners might make joint management decisions (e.g., concerning new features or whether to offer certain services), but this joint decision-making may not always be feasible. Another approach might be to separate decision management rights from decision control rights, similar to traditional corporations. As a software engineer clarified:

"Owning a number of shares allows you to have a voting right in the decision-making of the company and then you have a board of directors that are doing the day-to-day management of the company. That would be some people appointed by these Swarm token holders."

This suggests that the blockchain economy might have some centralization. However, there are also tendencies towards a decentralized locus of control. In particular, users offering services via Swarm City would be able to determine their pricing without inference from a third party. As a business leader explained:

> *"Uber always says how much I can earn per kilometre, per ride. So it's not really something I can decide. . . . We think that the people owning the item or the skill [they offer], they should decide how much they want to ask for and then they will see how the market will react to it."*

Decisions might be disputed, so resolving disagreements in decision making will be necessary. A drastic resolution is to fork the project, copying the code and setting up an alternative, competing project. Swarm City forked off from Arcade City due to Swarm City individuals who disagreed with decisions of Arcade City management. In the words of one of the Swarm City cofounders: *"Arcade City's still running, but we forked off into a separate organization, 'cause we had a certain way of wanting to do things".*

3.2. Accountability

In Swarm City, legal risks and obligations are delegated to the network participants. Our findings indicate that the claims that blockchain will entirely eliminate institutional engagement are exaggerated, since compliance with legal institutions will continue to be necessary in the blockchain economy. However, Swarm City neither assumes liability for the transactions it hosts nor does it compel its users to comply with legal regulations, since it perceives itself as merely facilitating peer-to-peer transactions. According to a software engineer:

> *I think that people who offer some kind of a peer-to-peer service, like ride sharing, in their local area, they should comply with the local regulations . . . . But it is up to the people who deliver the service to comply with those rules . . . . We are not intermediaries, we just offer a platform and in the end [we are enabling] a transaction on the blockchain, a peer-to-peer transaction, and we are not involved in that.*

Swarm City users may assume some legal liability for engaging in economic exchange, but mitigation mechanisms such as escrow and dispute-resolution assistance will be built into the system. Escrow can be entirely governed by a smart contract, but fulfilment of contract conditions might not be determined autonomously if transactions are bound to conditions the transacting parties must agree to after the fact. In such cases dispute

resolution mechanisms are necessary, but implementing such mechanisms in smart contracts is difficult, if not impossible. Therefore, institutional engagement may be necessary to resolve conflicts. As the Swarm City liaison officer explains:

> *Both [contractual] parties put money on a smart contract once they engage in a . . . transaction, [for instance] the ride sharing. The driver and the rider put money on the contract, in the end it has to be released. So if one of the parties is not satisfied or has a dispute, then . . . there will be another service like "dispute resolution" . . . that will be in the ecosystem. So it's another smart contract that gets triggered and there will be a person that steps in that has to resolve this problem.*

Swarm City grants identity using a public address in the blockchain network. The user needs this identity to engage in transactions. However, a user can also choose to use several public addresses. Moreover, the user can decide to remain pseudonymous. Swarm City tries to encourage users to identify themselves by tying all public addresses to reputation scores transferred across the sharing economy applications within Swarm City. This would make it easy for users to switch to new applications, and can be implemented fully on blockchain without institutional engagement. As a

business leader explains: *"You can earn reputation in riding, you can earn reputation in hosting or giving, renting out your apartment and so forth. And this gives you sort of a more realistic view of the person."*

3.3. Incentives

Swarm City's objective is to cut fees and redistribute to users the value currently captured by incumbent owners of sharing economy platforms. Swarm City seeks to remove intermediaries currently responsible for creating and governing sharing economy markets by transferring transactions and governance to blockchain in the context of a peer-to-peer economy. As the liaison officer states:

> *"The big difference with what we are building and with what blockchain can bring and how we want to bring blockchain to the people is that . . . almost all the value that you [create] will stay with you. So if I rent out a room in my house I [create] that value, if I rent it out to you I want that value coming to me. So [there is] no central party that is going to come in and claim a percentage of it."*

It is hoped that lower transaction fees will incentivize the use of Swarm City. There will also be behavior-influencing incentives; for example, offering

Swarm City users the opportunity to build a reputation that can be transferred across platforms. As a cofounder explains:

> *"And the ones with the really high reputations, people are inclined to trust them more, but the people with lower reputations are more inclined to offer cheaper services and try and do their best to build up their reputation, because if they don't, then they won't make any money, and then what's the point of them being there."*

Swarm City's core developer team intends to implement a fee system to reimburse those who maintain the infrastructure, thus creating an incentive for developers to propose new features. According to the liaison officer:

> *"There will be a small fee, but we are talking about one percent maximum, to sustain the platform. If there are some things to be sustained, if some bugs appear or something, that will need to get fixed . . . . We would like to have it more like a cooperative platform and not like all money coming to one central point and being dispersed from there."*

Swarm City developers also derived benefits from issuing their own cryptocurrency. The proceeds from the issuance were used to finance the development of Swarm City. In the future, this cryptocurrency might be used

to pay for transactions in Swarm City and might include voting rights or participation in decision-making. At present, the main motivation for developing Swarm City is ideological—to drive societal change. A blog post dated June 2, 2017 states: *"Now is the time to change society. We all feel it's up to us to try and become the change we want to see in this world."*

For creators of the individual sharing economy applications run by the Swarm City infrastructure, there is a monetary incentive to set up club goods, since they can embed a transaction fee in their application. Club goods are typically co-created and used by members and not owned by a single party. However, due to the competition of sharing economy applications, it is hoped that applications with minimal transaction fees will emerge, turning these applications into de-facto non-excludable goods and thus into public goods. Public goods are both non-excludable and non-rivalrous in consumption, which is why there are typically not well-functioning market mechanisms for providing them. It is hoped that the Swarm City infrastructure will change that. As a software engineer explains:

> *"The thing that I think we are changing the game with is that . . .*
> *everybody [will be able] to create these [sharing economy] storefronts*
> *and to suggest their own business model on top of it. You could even*
> *try [to charge] a 30 percent fee like Uber but I imagine that nobody will*

use that because there will be other options with much smaller fees –

or a zero fee."

Incentives play a crucial role in blockchain; while incentives are a key factor for eliciting desirable behavior by those developing, maintaining, and using Swarm City, they are also indispensable for ensuring that the underlying blockchain infrastructure (Ethereum, in the case of Swarm City) functions effectively.

4. Future IS Governance Research on Blockchain

As contrasted with the digital economy, the blockchain economy, challenges established notions of governance. Our research agenda is established to explore governance in the blockchain economy. We conclude by examining common assumptions in the blockchain discourse.

4.1. Extended IT Governance Framework

The Swarm City case clearly demonstrates that the emergence of the blockchain economy demands a rethinking of governance. At this early point in development, drawing from limited literature and early-stage case studies, it is not possible to see how blockchain will evolve, but we can begin to

evaluate how the radical changes foreseen for blockchain might affect

governance. By juxtaposing the blockchain economy and the digital economy

along the governance areas of decision rights, accountability, and incentives,

it is clear that the blockchain economy changes how we view governance

(see Table 3). The blockchain economy's emphasis on decentralizing

decision rights and the technical enactment of accountability underscores the

importance of incentive alignment. However, as our case study suggests,

these changes are fraught with tensions and conflicts, especially concerning

the degree of centralization and how accountability is enacted. We continue

here by discussing the three governance areas in terms of the blockchain

economy using the novel IT governance framework illustrated in Figure 1.

Table 3. Blockchain Economy Governance

| Dimension	Property (Range)	Digital Economy	Blockchain Economy	Selected Codes/Indicators
Decision rights	Degree of centralization (centralized—decentralized)	● The specification of decision rights is a known hierarchically organized contracting process. Implicit and explicit contracts define behavior in organizations. ● Records are decided upon centrally. ● Strict property rights prevent forking as a mode of resolving disagreement about decision-making. ● Transaction parameters are primarily defined centrally.	● The specification of decision rights needs to be organized in a decentralized environment. Implicit and explicit contracts are either not available or are solely managed by blockchain, making technology the foundation of the network instead of written agreements. ● Records are decided upon decentrally through consensus. ● Forking as a novel mode of decentrally resolving disagreement about decision-making. ● Transaction parameters are primarily defined decentrally. ● Initial high degree of centralized decision rights to enable decentralized control later on.	● Benevolent dictatorship (overcoming acute emergency situations, system design) ● Decentralized decision-making (setting transaction parameters, voting on proposals) ● Hybrid (centralized decision management rights and decentralized decision control rights) ● Resolving disagreement about decision-making (forking, voicing disagreement)
Accountability	Enactment (institutional – technical)	● Network as "nexus of contracts". ● Accountability specified in interpersonal as well as inter- and intraorganizational settings.	● Network as "nexus of smart contracts". ● Accountability specified in the network, delegated to and by the blockchain.	● Identity (technical origin, institutional verification, reputation, liability) ● Transaction enforcement (smart-contract-based escrow, institutional involvement)
Incentives	Alignment (aligned – unaligned)	● Digital processes in hierarchies for value creation of digital goods. ● Incentive to create private goods and club goods.	● Digital processes in peer-to-peer exchanges for value creation of blockchain-based digital goods. ● Incentives to create private goods, club goods, and public goods. ● New network-based processes which incentivize the peer-to-peer nodes to reach consensus.	● Incentives for technical consensus ● Incentives for system development and maintenance ● Incentives for users ● Incentives for token holders
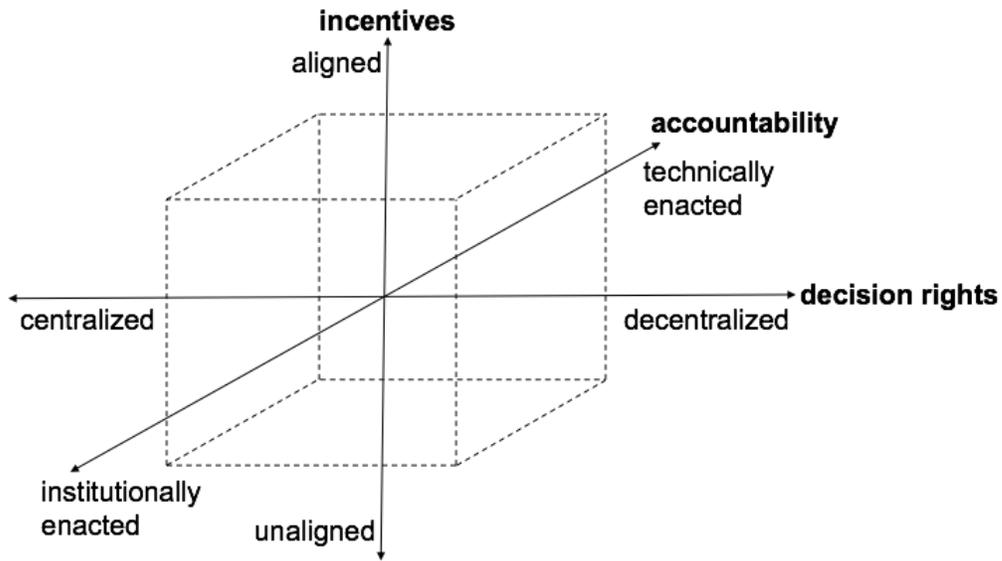
Figure 1. Extended IT Governance Framework

The blockchain literature and our case study suggest that the locus of decision rights in the blockchain economy will be more decentralized than in the digital economy. The nature of consensus-making underlines this development in particular. The locus of making consensus is decentralized, which means that the records that form the foundation of the blockchain economy are not only kept in a decentralized manner, but also decided upon in a decentralized manner. Moreover, disagreements can be resolved in a decentralized manner if users initiate forks by copying existing code and developing it further according to their goals. Our case study illustrates that beyond consensus-making or forking, concrete models for decentralizing

decision rights are still under development. Smart contracts might allow for decentralized governance mechanisms, but the blockchain economy at present continues to be characterized by a high degree of centralized decision-making. In particular, for effective system design, the concept of the "benevolent dictatorship" is deemed necessary. This illustrates that even though the blockchain economy shifts the focus toward decentralized forms of decision-making, there is still a high degree of centralization at this point.

In the blockchain economy, accountability in principle will increasingly be enacted technically instead of institutionally. Smart contracts allow for specifying and enforcing accountability. However, in some cases it may not be possible to implement autonomous transaction enforcement; thus, there will be disputes and institutional involvement will be necessary to resolve these disputes. A key accountability issue concerns identity in the blockchain environment, ostensibly granted through the public addresses that are used to conduct transactions in the blockchain economy. Given multiple and pseudonymous identities, this could be a problem. While many users will wish to identify themselves using more traditional institutional means (e.g., driver licenses linked to their blockchain identities), a more technical approach to instantiate identity in the blockchain economy would be to link reputation scores to public addresses, as the Swarm City case illustrates.

Overall, the shift toward the technical enactment of accountability has only begun, and we expect that institutions will continue to play important roles for accountability in the blockchain economy for some time to come.

As the blockchain economy emerges, incentive alignment becomes increasingly important. While incentives are at the core of all economic activity, including the digital economy, the blockchain economy adds a new dimension. Incentives are absolutely crucial for the blockchain economy to function effectively, because incentives are necessary to achieve the consensus that forms the backbone of the blockchain economy. Unless incentives are properly aligned, the nodes of the blockchain will not contribute to consensus. Improper incentive alignment threatens the integrity of the entire blockchain and makes the blockchain economy impossible.

4.2. Research Agenda for Governance in the Blockchain Economy

The blockchain economy demands a reassessment of established notions of governance. How exactly governance will change in the emerging blockchain economy is however still little understood. Nevertheless, the promise of the blockchain economy is dependent on the implementation of effective governance mechanisms, which are, in turn, dependent on a thorough understanding of the phenomenon. Table 4 summarizes our

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research agenda, which serves as fruitful ground for further theoretical work.

Table 4. Research Agenda for Governance in the Blockchain Economy	
Dimension	**Research Questions**
Decision rights	- How are decisions made in the blockchain economy? - How are decision management rights and decision control rights allocated? - How is disagreement about decision-making resolved in the blockchain economy? - What is the role of ownership in the blockchain economy?
Accountability	- How is accountability determined in the blockchain economy? - How is identity engrained in the blockchain economy? - How is transaction enforcement embedded in the blockchain economy? - How are disputed transactions resolved in the blockchain economy? - How is trust affected by the blockchain economy? - What is the role of institutions in the blockchain economy?
Incentives	- How is consensus incentivized in the blockchain economy? - How does incentive alignment work in the blockchain economy? - How is system use incentivized in the blockchain economy? - How is system development and maintenance incentivized in the blockchain economy? - How do business models shape the blockchain economy?

Future research should investigate how decision rights are allocated in the blockchain economy. As the Swarm City case illustrates, blockchain is subject to both instances of centralized as well as decentralized decision-making. Further research should analyze when centralized vs. decentralized decision rights are advantageous, and explore the mechanisms of transition from one to the other. Similarly, research is needed to articulate how decision-making works, and who is allowed to decide what kinds of things under what circumstances? Are decision management rights and decision control rights held by the same individuals or separated, and how does this affect the effectiveness of decision-making? The separation of decision

management rights and decision control rights has already been discussed in Swarm City in the context of professional management agents and token holders who might have voting rights. Resolution of disagreements about decision-making in the blockchain economy also needs research attention. With forking a possibility research should investigate the role of ownership in the blockchain economy. In traditional organizations owners allocate decision rights; however, in the blockchain economy ownership is not yet fully understood. Future research might analyze how ownership and decision rights are interwoven in the blockchain economy.

Researchers should address how accountability is determined in the blockchain economy and investigate the role of technical and institutional accountability. The topic of how identity, a crucial dimension of accountability, is handled in the blockchain economy should also be further explored. Identity can be both technically and institutionally enacted in the blockchain economy, but research is needed to better understand the associated limits and trade-offs. Transaction enforcement is also a fertile area for future research. Since transactions that are not autonomously enforced might require institutional accountability, researchers should investigate the boundary conditions of transaction enforcement in the blockchain economy to determine how best to resolve problems. Another promising area for

research is the role of trust. Will trust even be needed anymore? Do individuals trust the technology, expert developers, or the institutions that are still present in the blockchain economy? Institutions are likely to remain important in the blockchain economy, but what happens when institutions are not needed anymore? Will they fight back against the blockchain economy?

Finally, the role of incentives in the blockchain economy should be further explored. Among other things, research is needed to gain a better understanding of how incentives relate to consensus in the blockchain economy. What are the differences between incentive mechanisms such as proof-of-work and proof-of-stake? How does incentive alignment work in a blockchain economy that requires incentives not only for consensus, but also for system development, maintenance, and use? Can incentives be developed concurrently, how might they be interwoven, and how do circumstances of incentive alignment change over time? How do incentives affect system use in the blockchain economy? Do lower transaction fees for users create an incentive for system use? How can incentives be best provided for the development and maintenance of the blockchain economy? What effects do transaction fees, which may be necessary for covering costs, have on a blockchain? If every node in a blockchain system can use the blockchain, how are those who create the blockchain compensated? Can

blockchain offer the technological means and the incentives to make the creation of public goods attractive, given that traditional markets typically do not? Research is needed to investigate new business models for providing public goods, and to explore how developers might predict the needs and incentives of network participants.

4.3. A Critical Perspective

The blockchain economy is predicated on assumptions about several socio-technical issues that remain open to speculation. The widely heralded blockchain "paradise" calls for a critical stance. IS research can contribute to these problems only if research takes a critical view.

Many promises of the blockchain economy are predicated on technology reducing the coordination costs of economic activities. However, the costs of governance in the one DAO we studied appear to be high in spite of smart contracts. Smart contracts are valid indefinitely, but also entail high risk to the involved parties due to autonomous enforcement mechanisms in which coding errors or changes in conditions could have major consequences. The negotiation of smart contracts might bring substantial coordination costs to mitigate such concerns. It is too simplistic to say that problems will be handled by smart contracts. Mechanisms must be

specified and subjected to serious criticism and testing. While researchers may produce evidence that blockchain will lower coordination costs, they should also study DAO governance negotiating mechanisms, and examine they are created and maintained. Design-oriented research should create solutions for the risks of smart contracts, and propose risk management mechanisms that reduce some of these risks.

While user authentication cultivates accountability, it also invokes privacy concerns. These concerns could eventually be overcome, but if every transaction is visible in terms of the initiator and recipient, a cluster analysis could discern associations between different nodes. Private blockchain keys could be divulged, either intentionally or unintentionally, or attackers could eavesdrop on users. Informal exchange of transaction information could be linked to blockchain transaction data. Such privacy concerns are serious, particularly when a link is made between identities and transactions. For example, blockchain-based voting rests on the premise that every vote could be linked to the identity of the voter, making it difficult or impossible to guarantee anonymous voting. Pseudonyms might enable user authentication and thus accountability, but privacy concerns can complicate the use of blockchain, and trigger institutional pressures that prevent blockchain from realizing its ascribed potential. IS research needs to explore the

entanglement of accountability and privacy, studying how such issues affect individual human behavior such as willingness to engage in transactions on the blockchain.

The blockchain depends on the ability to achieve consensus. This presumes efficacy and efficiency of consensus mechanisms. At present these mechanisms are flawed. Blockchain depends on consensus mechanisms that provide the right incentives for nodes to guarantee blockchain integrity. Proof-of-work, the most common consensus mechanism, employed by both Bitcoin and Ethereum, relies on computing power. This causes environmental concern. In early 2018, Bitcoin's proof-of-work consensus mechanism was estimated to create a yearly CO_2 emission equivalent to one million transatlantic flights.[2] This is hardly desirable if blockchain is to be adopted on a large scale. Research to design more sustainable consensus mechanisms is ongoing, but the IS research community should actively involve itself in this work, studying the impact of mechanism parameters on the integrity of the blockchain, and exploring the effectiveness of proof-of-work mechanisms based on remuneration vs. proof-of-stake mechanisms that rely on sanctioning. Design-oriented research should craft mechanisms to provide incentives that ensure both the integrity

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[2] https://www.theguardian.com/technology/2018/jan/17/bitcoin-electricity-usage-huge-climate-cryptocurrency

of the blockchain *and* environmental sustainability.

5. Conclusion

In this paper, we discuss how blockchain might give rise to a new type of economic system, which we call the blockchain economy. Whether or not the blockchain economy develops as hoped, the ideas it invokes raise important research questions. Transactions that are enforced autonomously, following rules in smart contracts, look quite different than transactions in the digital economy. We set the stage for exploring such questions by examining the literature on IT governance that focuses on decision rights, accountability, and incentives. A case study of an emerging DAO examines the blockchain economy, and the implications for governance on these dimensions. We offer a research framework and agenda for IT governance in the blockchain economy, and provide additional important avenues for future IS research through critically examining current assumptions present in the blockchain discourse.

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