Blockchain Technology and Organization Science: Decentralization Theatre or Novel Organizational Form?

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Abstract

Blockchain technology, a general purpose technology that can facilitate the exchange of value and digital assets between counterparties without the need for traditional intermediaries, has the potential to influence several aspects of organization science. In this paper, we describe how the technology enables a new organizational form, which we distinguish as a discrete structural alternative to markets, hierarchies and hybrid organizations. We also identify a fundamental tension between the objective of decentralization, and the need for adaptation during an organization's early life. How a blockchain project manages this transition from founder-led to distributed governance determines whether or not it achieves a truly novel structure. We then discuss the conditions under which the "blockchain form" can be an advantageous organizational structure, evaluate areas where blockchain technology can (and cannot) complement how traditional firms are structured and run, and identify several promising research avenues for organization scholars.

1. Introduction

The paper explores how blockchain technology can be used to bootstrap a new organizational form, and related implications for organization scholars interested in studying the new types of distributed governance and coordination the technology enables. We also develop testable propositions about how and under what conditions this novel organizational form may offer a valuable complement to traditional firms and markets, as well as where it is unlikely to add value or provide a meaningfully different organizational design relative to what can be achieved within existing institutions and digital platforms.

Blockchain technology offers a method of permanently recording, storing and accessing information using a decentralized digital network – capabilities which can be used to coordinate economic activity on a global scale without relying on traditional intermediaries or centralized digital platforms (Catalini and Gans, 2016). The evolution of the technology is taking place in a distributed fashion across multiple geographic regions, with many firms, governments and universities having launched projects targeted at exploring opportunities in this space, often with radically different approaches to how the underlying technology is implemented, and how the resulting ecosystem is governed. We argue that a number of these experiments are based on a fundamental misunderstanding of where the technology can and cannot add value, and that the presence of competing narratives around decentralization and what can be achieved through the use of cryptography and code alone has generated unrealistic expectations about the types of digital institutions that can be built using the technology. We address this "bubble" in organizational designs by reconciling these narratives with a long-standing literature in organizational theory and related disciplines, and by separating what is novel about the blockchain form versus hype.

At a high level, blockchain technology allows participants within an ecosystem to maintain and update a set of shared data. In its most basic implementation (e.g. a cryptocurrency such as Bitcoin), this shared data is comparable to a distributed database of transactions. These transactions are often organized in batches called blocks, the order and contents of which become immutable over time as new records are appended. This process is usually maintained by multiple computing instances, called nodes, which collectively manage the read and write operations on the shared data, and uphold its fidelity by relying on a combination of cryptography and economic incentives. The existence of numerous distributed nodes means that blockchain technology offers a distributed way to agree on the true state of a set of shared data (i.e. reach "consensus") without relying on a centralized clearinghouse, making it robust to unilateral manipulation and removing the need to trust a single authority. In traditional implementations, this central authority or market maker gains a fair degree of market power over other participants, for example because it is able to oversee all transactions taking place in a marketplace, because it is able to curate them and decide who can participate versus not, and/or because it accumulates data over time on market participants that can be monetized through other channels.

While the use of cryptography and game theory provides a micro-foundation for why participants in a blockchain ecosystem may act honestly, the practical integrity of a blockchain application critically depends on how it interfaces with the offline world: the link between online "on-chain" activities recorded in a shared ledger and offline "off-chain" events present major challenges which cannot be overcome without complementary innovations and institutions (Tucker & Catalini, 2018). This has led technology enthusiasts to overclaim the types of applications the technology can actually address, as "last mile" problems plague distributed blockchain implementations in the same way they limit their centralized alternatives. For example, while one can send a Bitcoin transaction to anywhere in the world without being censored, such that the cryptocurrency has been used in situations where institutions have fallen apart to escape hyperinflation, being able to spend bitcoin to buy goods and services often still requires conversion into a local currency (i.e. Bitcoin runs into a "last mile" problem), which allows governments to control and censor transactions at the interface between the digital and the physical world.

We begin by providing evidence consistent with the view that a blockchain-based control structure can, under certain conditions, complement firms and markets and be considered a distinct organizational form. Whereas most projects at the time of writing do not meet these conditions (and many may never be able to do so), we highlight that a successful transition from a centralized, founder-led phase, to a more distributed, "permissionless" one constitutes a key test for assessing if a blockchain-based organizational design is truly novel, or if instead the technology is just used to improve existing processes and reconciliation of data across parties without meaningfully changing the relationships between them (e.g. in terms of influence, market power, etc.). We also discuss how this transition, in turn, depends on a challenging trade-off between the ability to adapt and innovate on an original organizational design, and the need to relinquish control to ensure participation and governance by a broader set of stakeholders.

This leads to a "decentralization paradox" in which for the organizational form to be novel and take advantage of the new types of institutional arrangements the technology enables, founders and early participants have to progressively reduce their influence over governance, even if such influence is what allowed them to bootstrap and successfully evolve the organization in the first place. Beyond the organizational challenges typically associated with a transition of power, this change in who has a voice in the governance and future trajectory of a blockchain-based organization can be further complicated by short-termism: while the overall long run value of a blockchain-based ecosystem might be higher in a fully "permissionless" state where a large group of entities finds it optimal to join, in the short run a more "permissioned" and controlled ecosystem can lead to more straightforward and immediate profits for the founders.

After having provided an overview of what is required for the new organizational form to be distinct, we delve into the conditions under which it may be advantageous relative to firms, markets and hybrids. Of course, firms can take advantage of the technology without reshaping their organizational boundaries and internal processes, changing how they create and capture value in a market, or affecting their relationship with other organizations and stakeholders. This may still lead to a lower cost of bureaucracy, and to tangible improvements in their ability to audit operations and offer transparency about them to other third-parties. We discuss these uses of blockchain technology that are less relevant from an organizational design perspective in Section 7, and focus most of the paper on instances where the organizational form is novel enough to shape market structure or the types of coordination that can be sustained in the economy.

Last, we also identify several promising research avenues for organization scholars. The public records and open-source nature of many projects in this space have led to an unprecedented availability of real-time data on contributions of talent and resources to blockchain-based organizations, as well as information on actual usage, performance and growth (Catalini, Boslego, and Zhang, 2019). These unique digital trails are likely to be invaluable for researchers interested not only in the study of the blockchain form and its evolution over time, but also of how it interacts with established firms and institutions.

2. Foundational Characteristics

Study of the phenomenon is complicated by the fact that blockchain is a rapidly evolving, general-purpose technology with multiple competing experiments and narratives around how it should be deployed and why.[1] In an effort to focus on dimensions that are less likely to evolve with technological advancements, in the paper we abstract away from narrow technical considerations and frame our discussion around more foundational characteristics that separate different experiments from an organizational perspective: the locus of control, degree of transparency, governance, and incentives.

Control refers to who can join, operate and maintain the shared data behind a blockchain-based organization. The two extremes on this front are fully *permissioned* systems, in which a single or small number of entities retains full control, and *permissionless* ones, in which market forces and low barriers to entry allow for participation by a large and fluid set of participants. *Transparency* refers to who can view and verify different parts of the shared data. *Governance* broadly relates to how the organization proposes and adopts changes to its rules and code. *Incentives* include the mechanisms in place to reward participation and the contribution of key resources needed to achieve the organization's objectives and growth.[2]

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[1] See Xu et al. (2017) for a taxonomy of blockchain-based ecosystems.

[2] For example, in the case of Bitcoin, the *locus of control* is distributed as the network is permissionless and anyone can become a node and validate transactions as long as they dedicate computing power to the network. *Transparency* is high since all Bitcoin transactions are pseudonymous and public, and anyone can download the entire transaction history at any point in time. *Governance* is implemented on-chain by relying on proof-of-work as a consensus algorithm, and off-chain through a process (Bitcoin Improvement Proposals, or BIPs) similar to the one adopted by standard setting organizations. *Incentives* include transaction fees paid to the nodes that verify and process transactions (miners), as well as a block reward (decaying over time) that is distributed when a new block of transactions is added to the blockchain. Bitcoin achieves consensus using proof-of-work (PoW), a process which involves cryptographic puzzles which are computationally expensive to solve, but whose correct answers are cheap to verify. Once these solutions are committed to the Bitcoin ledger together with the transactions they are based on, the use of proof-of-work makes it extremely expensive for any participant to unilaterally rewrite the Bitcoin transaction history. Bitcoin miners receive block rewards in the form of new bitcoin for solving these puzzles, thereby incentivizing investments

Multiple trade-offs constrain the design of blockchain-based organizations across these four dimensions. For example, the computations required to secure the Bitcoin network without relying on trusted intermediaries come at a high energy cost, but at the same time are what make it extremely difficult for anyone to modify the shared data unilaterally. They also allow anyone to enter and democratically participate in the formation of consensus proportional to the resources they bring to the network. This permissionless approach to coordination and governance translates into a high degree of openness and a low risk of expropriation by third-parties, but also makes adaptation and the evolution of rules and incentives very slow, as support from a majority of participants is required to implement any change.

Whereas all these core characteristics – locus of control, transparency, governance and incentives – influence the degree of novelty of a blockchain application, we argue that the first one is the most important from an organizational perspective, as it defines whether a blockchain-based organization can be considered a distinct organizational form or not. An organizational form is an archetypal configuration of organizational structures, routines and technologies that actors can rely on to structure their activities (Perkmann & Spicer, 2014). For it to be distinct, it needs to allow for novel arrangements that pre-existing forms either do not have a comparative advantage in, or are unable to completely replicate. While permissioned blockchain implementations are complements to firms and markets and can be integrated within existing forms because they enhance extant structures and routines, permissionless ones are more disruptive, and challenge some of the core assumptions that underscore both firms and markets. They also cannot be classified as a traditional hybrid organizational form such as a joint venture, nor be considered

in operating and safeguarding the network. These incentives have been called into question (Budish, 2018; Eyal & Sirer, 2014).

networks as described by Powell (1990). Rather, they should be considered a viable structural alternative (Simon, 1978) that makes new organizational arrangements possible.

From an economics perspective, blockchain technology lowers the costs of verification of digital information and coordination of economic activity (Catalini & Gans, 2016). The potential gains from its adoption thus hinge on the salience of these two key frictions within preexisting organizational and contractual relationships. On the one hand, interactions within firms and markets heavily rely on relational contracts (Macaulay, 1963; Geertz; 1962; Ostrom, 1990) that do not attempt to list all possible contingencies, but instead depend on a shared understanding of the overall objectives of an agreement. These contracts are built on trust and can be established despite high uncertainty about the future because the involved parties have a pre-existing reputation that would be costly to lose, or direct history with each other. While relational contracts underpin some of the most valuable transactions in the economy, they are difficult to build because the relevant actions cannot be specified ex-ante, and there is ample room for misunderstanding of the overall terms of an agreement if the involved parties do not have experience working with each other (Gibbons & Henderson, 2012; Poppo and Zenger 2002; Gulati & Nickerson 2008). This makes relational contracts difficult to port between institutions and contexts. Blockchain technology offers little advantage on these dimensions, and beyond increased transparency and lower cost of verification – which may accelerate the establishment of trust and reputation – will not alter the challenges individuals and organizations face in developing relational contracts.

On the other hand, some contracts and related contingencies and actions can be specified ex-ante and written down. Here, complementary technology – such as a tamper-proof GPS sensor or IoT device – that can solve last mile problems by taking information from offline events and recording it on a blockchain can drastically expand the range of agreements that can be supported under the blockchain form. Similarly, institutions that work on key complements to digital verification such as identity, reputation and curation systems, can enhance the logic and usefulness of the smart contracts[3] embedded in the rules and governance of a blockchain-based organizations.

Whereas the high-level distinction between relational and non-relational contracts is an important one for separating what blockchain technology can complement versus substitute, it is also useful to highlight that as institutions and technology progress, some activities that could only be conducted under the former tend to slowly transition towards the latter. A core premise of Bitcoin is that monetary policy – a complex relational contract between governments and their citizens – can be translated into a software-based contract that is predictable and impossible to change without support from a majority of constituents. While the resulting ecosystem may not offer an advantage to individuals living in countries with robust institutions and independent central banks, it may constitute an improvement in regions where governments are unable to maintain their promises. This could lead to relatively weak relational contracts being replaced by the blockchain form.

Based on the economic properties and governance trade-offs inherent in the blockchain-form, we now proceed to consider in more detail the conditions under which it can be considered a distinct organizational form.

[3] Contrary to what the name might imply, the legal status, jurisdiction, and enforceability of smart contracts remains highly underdeveloped, though it is beginning to receive attention from policy makers.

3. A Novel Organizational Form?

If blockchain technology allows for a distinct organizational form, then neither firms, markets nor hybrids should be able to fully replicate the types of activity and coordination it enables. The challenge is that a large share of experiments in this space do not constitute novel organizational approaches. For example, there is no change in organizational form when a centralized digital platform introduces blockchain technology to streamline its operations without changing its degree of influence and market power. While the underlying technology may be different, incentives and governance are the same. Similarly, when blockchain is used to operate an exchange under the same rules a traditional intermediary would follow, then the relevant dynamics are still those of markets. At the same time, there are reasons to believe that the blockchain form can constitute a distinct structural alternative because it can perform the following core organizational functions:

1. Motivation of agents to act toward the goals of the organization since doing so yields them the highest expected benefits (Luu, Teutsch, Kulkarni, & Saxena, 2015). In particular, the blockchain form can take the private-collective model further by complementing reputation and reciprocity motivations with monetary incentives (von Hippel & von Krogh, 2003a). This however also represents a risk, as monetary incentives can crowd out other non-pecuniary motives for individuals to contribute to a project.
2. Distributive and procedural justice, wherein contributors to an ecosystem can be rewarded and some types of disputes can be resolved in a transparent manner (Greenberg, 1990). That said, blockchain-based organizations are still prone to the same infighting, conflicts of interest and governance challenges that plague all coordinated groups, as can be seen in

the high-profile failures in the initial coin offering market (J. Roberts, 2017). The technology also offers new possibilities for dispute resolution.[4]

3. Learning and adaptation, wherein the technology is used to aggregate the preferences and beliefs of all participants, and evolve in response to changes in external circumstances (Levitt & March, 1988; Williamson, 1991). Blockchain implementations with tradeable tokens can be used to crowdsource preferences, aggregate opinions and expectations at scale (e.g. token curated registries), in a similar way that financial markets aggregate information about demand and willingness-to-pay (Hayek, 1945).
4. Flexibility in leadership, where control may range from concentrated in the hands of a small group of core developers to more democratic arrangements. The blockchain form can also support task specialization and incentive alignment between different stakeholders (Aghion & Tirole, 1997).
5. Freedom from (some) institutional constraints, since blockchain-based organizations are digital, they may be able to operate outside of geographic and legal barriers, or allow participants to rely on better institutional frameworks than the one they are embedded in (North, 1991).[5]

Based on the organizational, economic and governance trade-offs of the blockchain form, there will be conditions under which it may outperform (or not) existing structures.[6] At scale, the

[4] For example, dispute resolution initiatives Juris and Kleros are experimenting with tokenized arbitration protocols.
[5] The extra-institutional character of the blockchain form has begun to threaten its diffusion and maturation, as policy makers grapple with how to integrate it into existing legal and regulatory systems. Balancing compliance with institutional rules with the flexibility of decentralization is a critical challenge for blockchain organizations, since the most valuable applications depend on linkages to the physical world. For example, while Bitcoin transactions may be censorship resistant, exchanges in and out of the system need to comply with local laws.
[6] Each one of the blockchain form's unique characteristics may be a benefit in some settings and a disadvantage in others. As an example, consider the task of digital payments. Traditional digital payment providers had to provide incentives for early adopters to join their network, and had to register in each country and comply with local regulations or else risk sanctions to their centralized operations. By contrast, the Bitcoin code contained the basic rules needed to incentivize its adoption and diffusion as well as complementary investments by third-parties, such as digital wallet

resulting organizations are likely to look and behave very differently from traditional firms. Defining features of a firm include its legal incorporation, the existence of a bureaucratic structure for coordinating and administrating its activities, the possession of tangible and intangible resources, and a profit motive (Chandler, 1992). By contrast, we argue that blockchain-based ecosystems such as Bitcoin are an organizing structure even though they are unincorporated, have no leaders with fiat power, do not own any resources, and generate no profit at the enterprise level.[7] Importantly, the lack of an organization-level profit motive does not preclude participants from being partially or wholly profit-driven.[8]

While they are not firms, blockchain organizations cannot be considered pure markets either. A market is an institution that facilitates the routine exchange of specific goods that are somewhat stable over time, are able to be described and tracked, and have well-defined property rights (Rosenbaum, 2000). Furthermore, markets are a price-making system with transactions as their fundamental unit, and to which the chain of production – the making of the goods and services to be traded – is exogenous (Langlois, 1992; North, 1977). While blockchain can be used as a technology backend for markets and digital exchanges (e.g. to support the custody and transfer of digital assets), the blockchain form also involves decidedly non-market activities such as coordination, non-monetary rewards, alignment toward shared goals, and production (H. A.

providers and exchanges. At the same time, the absence of links to the existing financial infrastructure and of stability in price made it more difficult for individuals to adopt the cryptocurrency as a mass-market medium of exchange. One feature of traditional payments systems that Bitcoin lacks is transaction-level dispute resolution: the ability to reverse transfers due to fraud or misrepresentation. While this has led to many problems with Bitcoin – including transfer errors, scams and illicit activity – this absence of protections is also what makes a transfer on the network difficult to censor.

[7] Power structures do emerge in blockchain organizations and are critical to their evolution, as we discuss later in the paper.

[8] As mentioned above, this form is different from firms which employ blockchain technology in a permissioned way to raise capital or develop a new product, but are nevertheless traditional corporations. For example, Ripple Labs is a for-profit corporation developing a protocol for interbank money transfers using blockchain technology. It has owners, assets and a management team, and is not a blockchain-based organization.

Simon, 1991). Consider the Basic Attention Token (BAT), a blockchain-based advertising exchange platform designed to coordinate activity between content creators, advertisers and users. Its objectives go beyond sharing revenues from advertising with the users exposed to it. At its core, the BAT is an attempt to rewrite the relational contracts between all ecosystem participants, and redesign how user attention, user data, and original content are monetized online. While the underlying currency is needed to enable these interactions, as a whole, the BAT ecosystem has a mission that is substantially broader than facilitating advertising-related payments. It is thus neither a market nor a firm, but a new type of digital organization.

Prominent open-source initiatives, such as the Linux kernel and Wikipedia, have received significant attention in the organizational literature because of their self-governing mechanisms, contributor motivations, creation of knowledge, and community norms and goals (Faraj, Jarvenpaa, & Majchrzak, 2011; Lee & Cole, 2003; O'Mahony, 2007; von Hippel & von Krogh, 2003b). Like open source projects, blockchain-based organizations are often structured around a particular problem or opportunity. However, because of their unique ability to incorporate monetary incentives, they are distinct from prior models of collective production, open innovation[9] and open source development. The very presence of monetary incentives is a challenge for these communities, as it can crowd out pro-social contributions and self-motivation, and attract different types of participants that are predominantly focused on financial returns.

[9] Open innovation approaches enable firms to reach outside their boundaries and access external knowledge in a way that is distinct from licensing, joint venture or intellectual property markets (Chesbrough, 2003). Incumbents can use blockchain technology in a similar way to open the boundaries of their digital platforms to contributions by others. Ethereum co-founder Anthony Di Iorio has described his creation as "not a company, [but] a technology" in the sense of a general purpose platform (Kyle, 2018).

To further highlight the differences between these organizational structures, the table below presents a summarized comparison of markets, firms, hybrids and blockchain-based organizations.

Table 1: Comparison of Organizational Structures

	Market	**Firm**	**Hybrid**	**Blockchain**
Purpose	Match Supply & Demand	Maximize Profits	Project Specific	Flexible
Decision Making Mechanism	Revealed Preferences, Contract Terms	Fiat	Vote, Negotiation	Hybrid
Incentives	Prices, Contracts	Compensation, Career Concerns	Contracts	Prices, Cryptography, Smart Contracts
Incentive Alignment	High	Moderate	Moderate	High
Origin	Market Maker	Entrepreneur	Entrepreneur, Third-Parties	Entrepreneur, OS Community
Enforcement	Court	Diktat	Court	Self-Enforcing
Trusted Counterparty	Market Maker	Employee	Partner	Network, Code, Core Developers
Adaptability	Low	High	Moderate	Moderate
Structure	Virtual Entity	Legal Entity	Legal Entity	Virtual Entity

Property Rights	Independent, needs custodians	Pooled	Independent	Distributed with self-custody
Key Advantage	High-Powered Incentives	Coordination, Control	Resource Pooling	Trustless Coordination
Key Weakness	Incomplete Contracting	Principal-Agent Problem	Opportunism	Off-Chain Information
Key Cost	Transaction Costs	Monitoring Costs	Transaction Costs	Network Consensus Costs
Archetypal Application	Commodities Exchange	Intellectual Property Development	Shared Resource Development	Property Rights Over Digital Assets/Resources

4. The Decentralization Paradox

The archetype of a leaderless and self-enforcing organization often touted by blockchain enthusiasts is rarely observed in practice, as growing a blockchain-based ecosystem requires adaptation, effort and substantial investments of time and resources by its creators. At an early stage, founders face a trade-off between leaving enough room for offline governance – so that they can evolve rules and incentives – and making irreversible commitments towards restraining their influence over the same process through code. While founders can accelerate the pace at which rights are allocated to a broader group of constituents to limit their power and increase decentralization, this may slow down decisions or even lead to a tragedy of the commons.

Depending on the context, the additional burden decentralization imposes on coordination can be either a bug of the organizational design, or a feature. Bitcoin, for example, has been criticized for its inability to evolve quickly over the years. Similar to fundamental internet protocols like TCP/IP, its governance is designed to minimize the chance that rules can be changed in a unilateral way. By introducing rigidity and making institutional change extremely difficult, the blockchain form adopted by Bitcoin favors stability and predictability at the cost of being able to rapidly respond to new opportunities. This rigidity can lead to failure if rules and incentives are set at the beginning, designed in a way to resist change, and later discovered to be flawed or misaligned with the broader objectives of an ecosystem.[10] As they develop, blockchain-based organizations need to manage both the hold-up problems that may come from concentrated control – which can lead to underinvestment by other participants – and the coordination challenges that result from decentralization (Arruñada & Garicano, 2018). They also naturally become increasingly resistant to change as ownership in them becomes more distributed. There is therefore an early phase of adaptation and evolution, followed by one of relatively diffused governance.

The dynamics of this transition are perhaps the most challenging aspect of blockchain governance (Okun, 1975).[11] The tension between founders and other ecosystem stakeholders at large resembles the "dictator's dilemma" faced by benevolent autocrats: if the founder's promises are not enforceable, other participants may worry about ex-post renegotiation, but making them enforceable and relinquishing control too soon could mean risking redirection to a potentially inferior course of action (Wintrobe, 1998).[12]

This surfaces the key tension of the blockchain form, a tension between the ability to execute, iterate and evolve, and the need to relinquish control to allow for broad participation and ownership

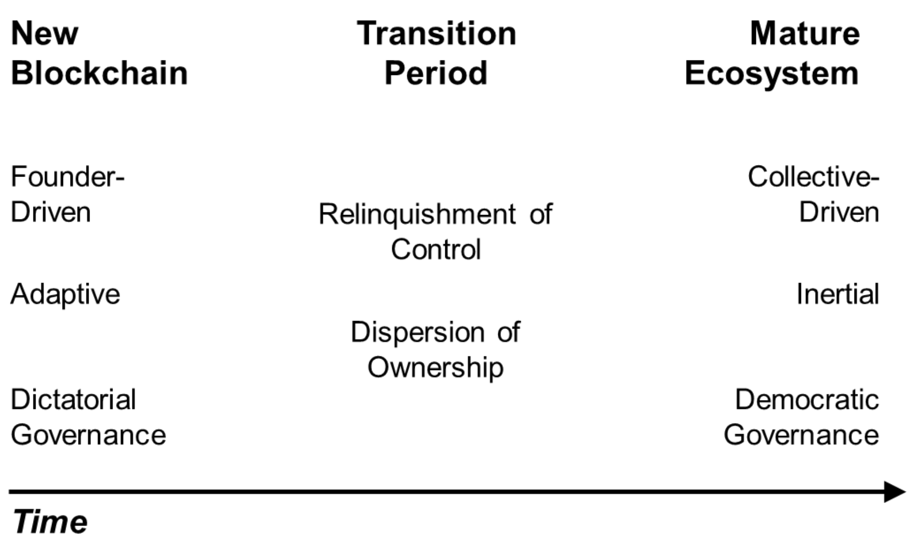
[10] Bitcoin is again a useful example here: launched as a form of digital cash platform, it evolved because of influence by miners and early investors into something more similar to a store of value (digital gold) than an efficient medium of exchange. While a part of its community is unsatisfied with this outcome, Bitcoin's design parameters embedded in the protocol are difficult to change, as they are analogous to constitutional choices that impact an organization's ability to evolve and adapt (Ostrom, 1990).

[11] Founders ideally evolve into "strategic leaders" (Selznik, 1984), advancing a vision and road map for the organization and promoting the exploration and exploitation processes needed for growth (Boal & Schultz, 2007).

[12] Whereas classical theories of modernization hold that democracy arises due to its functional fit with the needs of advanced economies, organizations are also believed to migrate towards the institutional arrangements that maximize their profits, irrespective of the degree towards which they maximize everyone's surplus (Alchian, 1950; Rueschemeyer, Stephens, & Stephens, 2013).

in the ecosystem. When a blockchain-based organization fails such a transition, and is instead stuck in a permissioned state where initial stakeholders retain too much influence over it, it collapses back to an organizational form that does not require the technology in the first place. This "decentralization theatre" – where firms may claim they are implementing the blockchain form only to recreate the same arrangements that favored them in the past – allows existing players to take advantage of the operational improvements the technology offers (such as reductions in the cost of verification), without any meaningful change in market power.

Figure 1: Evolution of a Blockchain Organization



In their discussion of the economics of the technology, Catalini and Gans (2016) identify this second dimension of change, which does rely on decentralization of control over time, as a reduction in the "cost of networking": by allowing economic agents to coordinate their actions through rules embedded in code and incentives, the blockchain form allows for collaboration to emerge in a digital ecosystem without assigning control to a central intermediary. The effects of this are particularly visible on digital platforms: whereas in traditional platforms the architect retains extensive control over its evolution and on who is allowed to participate and on what terms, in the blockchain form a digital platform is, at scale, owned by its participants, and so the benefits of network effects (such as interoperability between different services and applications) do not come at the cost of increased market power.

At the same time, since even a blockchain form that aspires to become fully permissionless and decentralized typically has to start with some degree of centralization, a mechanism is needed to irreversibly commit to the subsequent opening of the organization to distributed control. Moreover, founders need to be properly incentivized to not oppose such transition when triggered, even if it comes at the cost of lower returns in the short run.

This leads to a "decentralization paradox": for the network to scale and reach its full potential, founders need to relinquish control, but this comes at a personal cost to them and to early participants. This conflict between short run incentives and long run ones can only be resolved if founders are patient and willing to own a smaller share of a larger ecosystem, or if the transition itself is embedded into the constitutional parameters of the blockchain form. In practice, mining in proof-of-work systems is a mechanism to achieve this by ensuring that anyone can participate and contribute to a blockchain ecosystem. A key weakness of mining is that it also lends itself to economies of scale, reintroducing centralization in a system that was supposed to become more distributed over time. The search for better institutional arrangements on this front (such as proof-of-stake systems) is one of the most promising areas of research in this space from a technological perspective, as it may allow the blockchain form to better address the decentralization paradox.

5. Propositions About the Blockchain Form

We now turn to propositions on (1) when the blockchain form represents a novel way of organizing economic activity, (2) when this form is desirable, and (3) use cases that lend themselves to this new form.

5.1 The Blockchain Form is Distinct When Permissionless

> **Proposition 1.** The blockchain form is a distinct organizational structure of production when: 1) its founders no longer exert direct control over its evolution, instead having to rely on the rules and incentives embedded in the code to enact major changes like any other participant; and 2) entry and participation in the ecosystem are open to anyone, as long as they contribute resources towards the organizational goals.

While blockchain-based organizations may start centralized because of the presence of a founding team of developers or entrepreneurs, for the organizational form to be distinct from firms and markets, it needs to evolve into a permissionless ecosystem. This means that no single entity can unilaterally force change on others, participation is fluid and driven by market forces, and management by the initial set of core developers can be challenged.[13] Blockchain-based organizations that start and remain permissioned fail the transition that would actually allow them to expand beyond the boundaries of what traditional firms or markets are able to do, and as a result never incorporate market forces in the way they source talent, capital and resources. From a

[13] For example, debates over proposed alterations to the block size of the Bitcoin network – a technical parameter which affects the speed, security, and operating costs of the network – caused high-profile fractures between the core development team and newly-influential groups (see, for example Morris, 2017).

market-structure perspective, while permissioned organizations leave a fair degree of market power in the hands of their architects, at scale, permissionless ones more closely resemble competitive markets (Catalini & Tucker, 2018).

Permissionless blockchain-based organizations are slower to adapt because of their distributed nature, but their openness allows them to support coordination of economic activity at a scale that is difficult to replicate for a single firm. By design, a permissionless protocol resembles a technology standard that anyone can use and build on top of. This allows competitors to achieve interoperability with each other without trusting a third-party. It also reassures entities making specific investments in an ecosystem that they will not be expropriated ex-post by the platform architect. For example, the entities that invested in building data centers around the globe to secure the Bitcoin network did so simply because of the incentives embedded in the Bitcoin code and the technical guarantee that it would be impossible to alter the rules of the system without a majority of participants supporting the change. This process for deploying a large-scale network stands in stark contrast to the one followed by networks in telecommunications, electricity, railroads, or the financial sector, where often the sponsor is either a government or a consortium of firms. In the case of the blockchain form, infrastructure buildout can be simply the result of code, incentives and individual agents realizing that they can profit from participating in the early stages of a new ecosystem.

Permissionless blockchain organizations are not firms, since they do not need to be incorporated, nor have owners or formal leaders. They are also not markets, as they can replicate some of the governance and contractual arrangements used within the boundaries of the firm. It would also be incorrect to classify them as hybrids (as they do not need to result from alliances, partnerships, or joint ventures), or networks (as they do not rely on social ties or reciprocity between participants, nor are they an alternative solution to the vulnerability-to-defection problem which motivates networks). Last, they do not need to be open source communities. While they may rely on open source code, they can mix monetary and non-monetary incentives in a way that is fundamentally novel both from the perspective of an open source community as well as that of a firm engaged in open source development.

A governance structure is unique not because it differs on *every* dimension from alternative forms, but because it has a different combination of attributes which results in the capacity to make decisions and adjust to the environment in a novel way (Ménard, 2004). Permissioned blockchain-based organizations, because of the unique trade-offs they allow organizations to make, fulfill this challenge.

5.2 Desirability of the Blockchain Form

To be more than a curiosity, the blockchain form must be not only unique, but also desirable in some cases relative to alternatives.

> **Proposition 2.** The blockchain form is a more efficient production model than markets or hierarchies in environments characterized by high costs of networking or verification.

The "discrete alignment principle" suggests that alternate governance structures will be chosen as agents attempt to reduce transaction costs by aligning the organization with the characteristics of the exchanges it tries to support (Williamson, 1991). That is, organizations which fit the demands of their environment better will thrive at the cost of those that do not (Lawrence & Lorsch, 1967). But what are the types of goods and services for which one could expect the blockchain form to be a superior mode of production? Institutional factors are important moderators in this context: for example, the self-enforcing nature of smart contracts may be particularly valuable in regimes with weak legal protections, as well as for coordinating activity and standardizing agreements when transacting across multiple jurisdictions. The geographic fragmentation of legal and regulatory jurisdictions is a meaningful cost for collaboration and trade over distance. Smart contracts allow the same code to be applied to all participants, theoretically solving this problem. At the same time, it is not clear what level of opposition they may find from governments, and if international frameworks will emerge to support them. Authorities can still restrict enforcement for any contract that needs to interface with the offline world, or prosecute individuals and organizations that use a blockchain to escape local laws.[14]

We now discuss in more detail three specific use cases for which the blockchain form may be comparatively well-suited despite these limitations: the management of property rights over digital assets and resources, distributed innovation, and nascent networks.

5.3 Property Rights Over Digital Assets and Digital Resources.

Because of the way blockchain-based organizations can verify the current state of digital records without the need to trust a central authority, they are well suited for tracking ownership and changes in digital assets, and facilitating the trade of digital resources. This includes a broad range of objects such as information, online content, software, financial instruments, as well as

[14] Part of this tension is already visible within the Bitcoin ecosystem: while technically anyone can transfer value to anyone else independent of location, the ability to exchange to and from fiat currencies is increasingly regulated. In general, the need for smart contracts to interact with the offline world to be actually useful, also vastly narrows the space of agreements that can be made censorship-resistant.

resources that are easy to digitally meter such as bandwidth, data storage, and computation. Blockchain technology also uniquely allows individuals and organizations to "self-custody" digital assets without the need for intermediaries such as banks. Rather, assets are collectively maintained by all participants in the network, and control over them is in the hands of the asset owner. While self-custody has theoretical advantages – including greater privacy, high portability of service between providers, and increased market competition – in practice, significant work is still needed to reap its benefits, as the technology does not currently offer the same degree of convenience relative to extant centralized solutions consumers are used to. For example, while Bitcoin users can store their own keys, a large number of them relies on a third-party to do so, essentially trusting this entity with their funds as with a traditional bank.

Proposition 3. The blockchain form is an efficient way to self-custody, verify and trade property rights over digital assets and easily measurable digital resources.

5.4 Distributed Innovation

The blockchain form, when permissionless, aligns incentives between developers working at the protocol layer and those working at the application layer of an ecosystem. This may be more efficient than the bureaucratic governance structures that often emerge in open source communities (O'Mahony & Ferraro, 2007), as it allows for coordination without concentrating power in a small group of developers or code contributing entities. The resulting platforms are also less prone to censorship or expropriation by the marketplace owner (Catalini & Gans, 2016). While Apple and Google often integrate successful applications that emerge from their ecosystems into their mobile platforms, this would not be possible within the blockchain form. Similarly, the platform architect would not be able to use its control over the ecosystem to exclude competitors.[15]

Proposition 4. The blockchain form is more efficient than traditional digital platforms and marketplaces or open source communities when the risk of ex-post expropriation by the platform architect is high.

5.5 Nascent Networks

The blockchain form is well suited to incentivizing the early contributions of talent, ideas and capital needed to develop network-based services. It allows for coordination to emerge when network effects are present (Catalini & Gans, 2018), and lets founders transparently use market-driven forces to discover the value different participants bring to an ecosystem. Because of the reduction in the cost of networking and of coordinating activity among multiple stakeholders, the blockchain form decouples the benefits of network effects from the detrimental costs of market power (Catalini & Gans, 2016). This has positive implications from an antitrust perspective, as it expands society's ability to support alternatives to the dominant digital monopolies (Catalini & Tucker, 2018).

Proposition 5. The blockchain form has the ability to support the growth of platforms that can decouple the benefits from network effects from the costs of market power.

[15] As Microsoft did when it integrated Internet Explorer inside of Windows to challenge Netscape's dominance in the new web browser market.

6. Comparative Analysis of the Blockchain Form

In this section, we further separate the blockchain form from markets, hierarchies and hybrids along the key dimensions of *contract law*, *adaptation* and *coordination*, drawn from Williamson's (1991) analytical framework of comparative economic organization. We also introduce the additional dimensions of *purpose* and *trusted counterparty* to highlight some of the unique possibilities afforded by blockchain-based organizations.

Contract Law and Dispute Resolution. Market-based exchange is enforceable through lawsuits, magnifying the challenge of properly specifying contracts between parties ex-ante. By contrast, intrafirm disputes are generally not admissible in court; rather, managers have broad power to resolve issues through fiat. Within digital arrangements, the blockchain form is uniquely self-enforcing, in that its protocol can both define and enforce digital contractual rules via the execution of smart contracts. Enforcement is a result of network consensus, and rules can only be changed if a majority of participants support the edits.[16]

While it may be tempting to believe that this allows participants to enforce contracts in a novel way, it is important to highlight that it relies on the entire contract being executable within the digital realm. As discussed in Tucker & Catalini (2018), at the interface between online records and offline activity, blockchain technology is useless in the absence of reliable mechanisms targeted at keeping offline events in sync with their digital representation. If a contract relies on arbitration, and such arbitration requires information outside of the shared data which the ecosystem relies on for its regular operations, then self-enforcement is impossible.

[16] The meaning of majority depends on the design of the blockchain. Majority power may be defined in terms of computational power, wealth, number of users, or any other digital attribute visible to the network.

Smart contracts, moreover, are in no way immune to the challenges of incomplete contracting that weaken traditional contracts. For example, when the assets of the Decentralized Autonomous Organization (DAO), an early blockchain-based venture capital fund running on the Ethereum ecosystem, were stolen by hackers, the community was faced with an unforeseen dilemma: maintain the constitutional rules of the existing network, thereby allowing the thieves to essentially get away with the heist, or implement a "hard fork" which would rewrite history, return the stolen funds to the DAO contract, but ultimately undermine the fundamental belief in the code being the predictable and irreversible law governing the ecosystem. Therefore, relational contracting and reputation will continue to be critical complements to on-chain governance for blockchain organizations.

Adaptation. Unanticipated changes for which prices do not serve as sufficient statistics require market-based contracts to be renegotiated, which is costly and leaves room for opportunism. Whereas firms can adapt more flexibly without delays and bargaining,[17] and hybrid forms can use repeated relational contracts and private dispute resolution processes to achieve adaptive capability without vertical integration, the blockchain form is relatively less flexible due to the need for network consensus. However, the blockchain form is more adaptive than a market because it can contain built-in mechanisms to evolve and correct errors, as demonstrated by successful community-led rule changes by large blockchain ecosystems (both the Bitcoin and Ethereum core developers maintain an improvement proposal system to track and manage the evolution of their platform).

[17] Although this comes at the cost of reduced incentive alignment, since agents do not hold full residual claims to the outcome of their actions on the organization

Coordination. The ability to coordinate work around complex objectives is considered a fundamental property of the firm (Kogut & Zander, 1996). Intangible activities, moreover, are difficult to contract for externally because of challenges with assessing quality when key dimensions of performance are not easily observable by all parties involved, and when effort is only noisily related to outcomes (as in R&D activity). Similarly, in the absence of effective property rights, markets for ideas tend to unravel (Gans & Stern, 2010), and innovators have to develop ideas in-house in order to appropriate the returns from their inventions.

While blockchains can use incentives to reward outcomes that are easily measurable and verifiable digitally (the canonical example here is "mining", in which the network doesn't need to monitor data centers to know that they've expended energy and computation towards solving a cryptographic puzzle and securing the shared data), the same challenges mentioned earlier about keeping offline events in sync with their digital representation still apply here for any activity that is not entirely digital. Once more, at the interface between the offline world and the online one, intermediaries are needed to reliably report information back "on-chain". This drastically limits the types of coordination that the blockchain form can sustain, and as a result many of the constraints markets face in facilitating coordination, also apply to blockchain-based organizations.

A key exception is coordination and incentive alignment between individuals and organizations working to improve the protocol layer (i.e., the "public infrastructure" everyone relies on), and those working on the application layer. In this case, alignment naturally results from the positive feedback loop a single successful application can have on the overall ecosystem: as in traditional digital platforms, the value of a blockchain ecosystem increases as new useful applications are discovered and built. Of course, the feedback can also be negative: when excessive entry by low quality projects caused the initial coin offering market to experience high degrees of fraud, the entire Ethereum ecosystem suffered, and the value of the cryptocurrency plummeted (Catalini et al., 2018).

The relationship between the protocol layer and the application layer is a particularly interesting one for organization science scholars, yet it is familiar from a different context: the relationship between entrepreneurial ecosystems and the organizations they enable. The blockchain form's reliance on a sizable public infrastructure layer can result in a tragedy of the commons: while everyone benefits from improvements in the protocol layer, most appropriation happens at the application layer, leading to underinvestment. This issue is less pronounced during a blockchain's expansion phase, as price appreciation in the underlying token provides enough returns for all participants. For example, a number of firms contribute code and talent to the Bitcoin codebase, as advancements in the protocol and in its security help them build better applications on top of it. But as expansion and appreciation of the token slow down, ecosystem participants will have to coordinate to maintain the public infrastructure they have built, and tensions may arise with respect to what resources each large stakeholder should contribute. From a code development perspective, blockchain-based organizations resemble open source communities. As in open source, coordination work – including managing interdependencies, dealing with contingencies and boundary spanning – may be undersupplied. Because these functions are so valuable, those who undertake them tend to rise to authority roles, which they may then use to undertake further coordination (Dahlander & O'Mahony, 2011).[18]

[18] In a study of the emergence of governance in open source communities, O'Mahony and Ferraro (2007) show how hierarchy emerged in the Debian community even though there was no obvious basis for authority ex ante. Alternatively, role-taking "in the moment" has been observed as a generative response to dispute resolution and goal setting in the decentralized collaboration process. Like other open source communities, a characteristic of blockchain ecosystems is their fluidity, wherein participants dynamically enter and exit, as well as wax and wane in their participation. This gives rise to unique knowledge collaboration dynamics not present in traditional hierarchies, such as participants adopting and shedding leadership roles to advance a specific situation (Faraj et al., 2011).

Purpose. Markets are designed to efficiently match parties who wish to trade, whereas firms are designed to maximize organizational goals (including profit).[19] Hybrid forms, by contrast, aim to divide benefits of shared investments and commitments in a mutually agreeable manner. Because of its open source roots, the blockchain form can be more flexible than a market, and can orient around pecuniary and non-pecuniary incentives.[20] On one extreme, some blockchain-based organizations focus exclusively on profit maximization. For example, the hedge fund Numerai, which uses a native token to aggregate and reward the contributions of many data scientists across the globe, seeks to solve the scaling problem traditional hedge funds face when trying to attract the best talent by framing the development of trading algorithms as a collaborative data science challenge.[21] In contrast, the blockchain form can also be used to accomplish additional objectives beyond profit maximization. For example, Bitcoin aims to provide a store of value that is both global and censorship resistant, while Filecoin wants to achieve similar objectives for data storage. Whereas in the first case the organizations being challenged are central banks and parts of the financial industry, in the second it is centralized storage solutions such as those offered by Amazon, Dropbox, Microsoft or Google. By taking advantage of the blockchain form, both ecosystems can allow for free entry and exit by both suppliers and consumers of the digital services they provide and allow developers to build services on top of them without the need to obtain permissions or licensing from a central entity (hence their "permissionless" nature). This ability to

[19] In their rejection of the application of the stakeholder perspective to managerial decision making, Sundaram & Inkpen (2004) conclude that the corporate objective must unambiguously be profit maximization.

[20] Of course, the addition of monetary incentives represents both an opportunity and a challenge for open innovation ecosystems, as the profit motive may crowd our pro-social contributions and dilute over time the broader mission of the ecosystem.

[21] Financial input data are abstracted so that participants do not know what they represent, and data scientists only reveal their predictions, not their models, thus solving Arrow's disclosure problem for both sides of the market. To avoid incentives for overfitting of the input data, participants are compensated based on actual performance of the hedge fund through the token, which essentially makes them shareholders in the decentralized organization (Craib, Bradway, Dunn, & Krug, 2017).

freely develop applications for an ecosystem without the risk of being censored or expropriated ex-post by the platform architect (platform-level censorship resistance) is a key feature of the blockchain form that traditional digital platforms cannot offer (Arruñada & Garicano, 2018; Catalini & Gans, 2016; Catalini & Tucker, 2018).

Trusted Counterparty. Courts and managers are prone to error and bias. Similarly, blockchain-based ecosystems are vulnerable to bugs introduced by their developers and errors in their incentive design. Conditional on the rules and incentives being correct, and the system not being under attack, blockchains guarantee predictability in outcomes and execution of smart contracts without the need for trusted intermediaries. Issues of incomplete contracting aside, and assuming again that the relevant information can be reliably obtained on-chain, this characteristic upends some of the issues of reputation and opportunism that play a central role in organizational theories. In practice, blockchain-based organizations require trust in the core development team, especially in the early stages of their development where adaptation is more important. Open source code notwithstanding, it is impractical (and unlikely) that all participants will audit a blockchain ecosystem, and most users will trust larger stakeholders to perform this function on their behalf, bringing principal-agent issues back into the fold.

Ironically, because of users' tendency to delegate code maintenance and platform governance to others, blockchain ecosystems may gravitate back towards centralization. The market for delegation is one where brand, reputation and network effects are present, leading to concentration. An example of this is the increasingly important role that digital wallet providers play in the cryptocurrency space when controversial governance decisions arise or when the ecosystem is under attack: by deciding to support a specific fork or not, or by blocking transactions when an attack is in place, wallet providers are acting like activist shareholders. This is likely to become even more prevalent as ecosystems move towards proof-of-stake-based consensus: while in such a system everyone can technically influence governance and vote in a way that is proportional to their stake, if the majority of users utilize a third-party custodian, they will in effect delegate governance and control over the ecosystem to a potentially small number of entities.

7. Blockchain and the Firm

The theory of the firm depicts the corporation as a response to frictions in the market and market failures (Mahoney & Qian, 2013). The classical answer to why firms exist is that some activities are cheaper to organize by fiat as compared to markets, for example due to high uncertainty which can make complete contracts difficult to specify (Coase, 1937).[22] In this section, we discuss how blockchain technology may shape the operations of the firm.

Vertical Integration

[22] Institutions play a primary role in moderating the trade-offs between firms and markets (North, 1991). Firms are more than a "legal fiction which serves as a nexus for contracting relationships" (Jensen & Meckling, 1976), and can adapt their governance structures to changes in the environment (Williamson, 1971). When deciding their boundaries, firms also face a trade-off between bureaucracy and rent-seeking behavior (Gibbons, 2005). The behavioral perspective views firms as a coalition of stakeholders who acts based on a decision system in response to objectives, costs, and future expectations (Cyert & March, 1963). Furthermore, knowledge and resource-based theories of the firm have elaborated how firms create value by promoting the assimilation, development and transfer of know-how, capabilities, and core competencies (Grant, 1996; Kogut & Zander, 1992; Wernerfelt, 1984). The firm is both an administrative unit and a collection of productive resources (Penrose, 1959). Hybrid forms between firms and markets seek to improve adaptability while preserving some of the incentives of ownership autonomy (Williamson, 1991). These generally consist of long-term relationships between firms (or other institutions), that allow participants to share rents and make interdependent investments in complementary assets (Ménard, 2004). Powell (1990) rejected the completeness of the market-hierarchy continuum and proposed the existence of a third form of "network" organizational structure, characterized by agents linked by strong ties. Networks are looser structures dependent on relationships and reputation, and are governed by mutual trust and normative sanctions – characteristics that are fundamentally different from the anonymity and transactional relationships often observed in the blockchain-form. They are characterized by an ability to adapt to change and foster reciprocity, particularly with respect to knowledge-based activities. Whether networks are in fact a distinct logic, or in fact a type of hybrid form, has been the subject of debate in the literature (Williamson, 1991; Zuckerman, 2014).

The study of vertical integration has been broadly divided into the decision to forward-integrate (become a retailer), and the decision to backward-integrate (make-or-buy) (Lafontaine & Slade, 2007). Taking the transaction as the unit of analysis, the firm is assumed to economize on the sum of production and transaction costs when selecting the appropriate governance structure. Transactions are therefore more likely to be internalized when they are recurrent and entail idiosyncratic investment or high uncertainty – yet this comes at the cost of bureaucracy (Williamson, 1979) and does not eliminate hold-up and opportunism, as similar issues can arise between business units under vertical integration (Cyert & March, 1963; Klein, Crawford, & Alchian, 1978).

Blockchain technology reduces the need for backward integration because it gives firms the ability to monitor and verify the authenticity of digital information throughout a supply chain, reducing transaction costs. This is greatly augmented by the availability of complementary innovations targeted at keeping offline events in sync with digital records. With respect to forward integration, the technology offers a novel way to reach customers directly through different types of tokens. Utility tokens, for example, are digital assets that confer the right to use a product or service. They can be cheaply issued, tracked and traded on a blockchain, allowing firms to easily create marketplaces around their offerings. Tokens can also be used to assign ownership of a digital asset (e.g. a collectible), or to license its use for a period of time.

Overall, since blockchain technology can lower transaction costs for incumbents, it may allow for low-cost extensions of complementary assets, such as brands. This is a countervailing force to the ability of entrants to use the blockchain form to compete against established network effects.

Proposition 1. When the cost of verifying digital information is a key obstacle to relying on a market ("buy"), blockchain technology will reduce the need for backward integration ("make"). Similarly, the ability to cheaply monitor and track digital assets will enable firms to experiment with new forms of forward integration and licensing.

Innovation and R&D

The use of tokens allows firms to bootstrap digital markets around their products and services that third-parties can join without the risk of expropriation by the firm itself. The same tokens can also be used to raise non-dilutive capital, and to discover consumers' willingness-to-pay when future demand is uncertain (Catalini & Gans, 2018). This capability is particularly valuable in contexts where it is costly for firms to search the entire opportunity landscape, when the environment is turbulent (March, 1991), and when tokens can be used as transparent and decomposable elements of a modular system (Baldwin & Hippel, 2011).[23]

Proposition 2. A blockchain can be used as an innovation platform for unstructured problems with built-in fundraising, demand discovery, and property rights allocation. Relative to other platforms, the key difference is the ability of a firm to use cryptography and incentives to make irreversible commitments to the third parties invited to join the platform.

Capital Raising and Governance

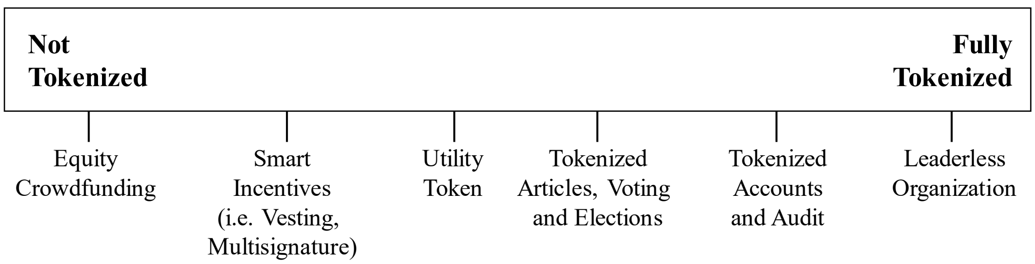
[23] This encourages end users to create new products and services to meet their needs using components from different ecosystems: for example, an entrepreneur could create a subscription-based data backup and recovery service by integrating both Filecoin and Bitcoin. Exchange protocols such as 0x are being developed to facilitate this type of modular recombination.

Blockchain-based fundraising is more likely to become a complement rather than a substitute for traditional sources of capital. In the crowdfunding context, platforms that aimed for full disintermediation from professional investors have struggled with fraud and information asymmetry, leading them to ultimately reintroduce professional investors to avoid the unraveling of the market (Catalini & Hui, 2018). Similar issues, together with regulatory arbitrage and lack of transparency, have plagued the market for initial coin offerings, where tokens have been used by many low-quality teams to raise capital without many of the safeguards and provisions of traditional early-stage capital markets. This has pushed a number of startups in the blockchain space away from using tokens as a direct fundraising mechanism from the crowd, with future tokens being sold to angel investors and venture capitalists instead.

Firms may primarily benefit from the flexible fundraising framework enabled by tokens not as a substitute for traditional debt or equity instruments, but as a way to create programmable securities that evolve with time, even if issued within current regulatory frameworks. While early uses of tokens were unregulated and predicated on self-custody, these hybrid instruments typically require a third-party for ensuring compliance like traditional ones. Smart contracts give more flexibility to firms in terms of the governance, voting and dividend rights these securities have at different points in time, or when different milestones are reached. For example, as the market cap of a token increases, its governance can evolve to accommodate for a broader participation among its stakeholders.

Depending on the degree of corporate governance that is performed offline versus on-chain, tokens can play different roles for a firm: on one extreme, they are simply used to implement basic contracting logic ("smart incentives"); on the other extreme, they confer the full voting and governance rights traditionally associated with ownership in an organization, and all activities take place on a blockchain ("leaderless organization"). Because of the issues we discussed so far, and in particular the large initial frictions organizations will face in correctly converting offline events into online records, while open source communities may experiment with the far end of the tokenization spectrum, established organizations are more likely to focus on applications that incrementally extend the capability of debt and security instruments that they already utilize.

Tokenization of Corporate Governance



Shareholders of large corporations today delegate control to elected directors, who are supposed to represent the interests of the equity claimants, for several reasons. First, managerial decisions in complex organizations are more efficiently run by those with specialized knowledge. Second, when there are many residual claimants, it can be costly for them to participate in and ratify all decisions (Fama & Jensen, 1983). Practical costs associated with disseminating information and ballots, and tallying proxies, can be substantial. Blockchain technology could be used to reduce the cost of coordinating votes on corporate matters.[24]

While on-chain voting is cheap, easy and convenient, last-mile considerations again come into play to threaten the integrity of the voting process; this same difficulty explains why electronic

[24] In such a system, shareholders wishing to outsource their voting responsibilities could assign their voting rights or research function to a fiduciary representative, such as a professional director or a proxy advisor. This is not dissimilar to the practice of many institutional investors today with respect to voting and proxy advisors (United States Government Accountability Office, 2016).

voting technology has yet to be adopted in the political context. Reliable equal (as opposed to token-weighted) votes are infeasible without a method of matching tokenholders to verified identities, since individuals could otherwise spread their holdings across multiple wallets to increase their influence. In addition, the vulnerability of on-chain voting systems to vote buying far exceeds that of traditional voting due to the ability of entering into enforceable side arrangements with vote manipulators (Daian, Kell, Miers, & Juels, 2018). Therefore, some of the frictions in the traditional voting process – such as physical presence and identity checks –give polling places a decisive edge over on-chain voting with respect to fairness and integrity. Depending on their objective, blockchains may thus need to strategically reintroduce frictions into the process to increase the costs of manipulation.

Proposition 3. Blockchain technology can increase flexibility in capital raising via higher automation, earlier liquidity for investors, increased transparency, and programmable, milestone-based funding and governance rights.

Disclosure

Decreased costs of verification have the potential to improve governance, lower monitoring costs, and reduce information asymmetries between firms and stakeholders when the process generating the necessary information is fully digital. This is likely to be the case within online platforms, and industry verticals such as finance where transactions leave reliable digital trails and assets are digital. At the same time, firms adopting the technology do not need to embrace a model of "radical transparency" where all of their information is disclosed, as advances in cryptography (such as zero-knowledge proofs) allow for verification without disclosure of the underlying data.

Accounting information plays a major role in capital markets, and significant resources are devoted to producing standardized, audited disclosures of corporate information (Beyer, Cohen, Lys, & Walther, 2010). Blockchain technology may lower the cost of verification by improving accessibility, reliability and transparency of information. In an extreme case, if financial transactions are automatically recorded on a shared ledger, the blockchain could automate audits and produce real-time audited financials. This move from sample-based testing to monitoring the whole population of transactions could "drastically increase the level of assurance" in financial reporting (Psaila, 2017). This is analogous to the advanced systems in place today to detect fraudulent credit card transactions, which use machine learning to detect anomalous usage patterns. Powerful and low-cost artificial intelligence systems are already transforming decision making, yet their widespread acceptance will depend on making the underlying data and process used for decision making auditable and accessible (Agrawal, Gans, & Goldfarb, 2018).

If equity is traded on a blockchain, the technology could also offer more accurate, timely and trustworthy information about the shareholder register, insider trading activity, and collateral pledges or short sales (Yermack, 2017). Therefore, blockchain technology may facilitate higher valuations and improved access to capital by facilitating better disclosures.

Proposition 4. Blockchain technology allows firms to credibly disclose information to third parties, allowing for real-time audits and a higher degree of transparency.

8. Research Avenues

Blockchain technology is still in its infancy and is currently characterized by high levels of investment and uncertainty, as is typical of disruptive innovations (Branch & Evans, 2011;

Gilchrist, Himmelberg, & Huberman, 2004; Johnson, 2007). It is thus subject to many of the risks familiar to those who have studied nascent technologies; here, we highlight three challenges unique to the phenomenon which deserve special attention and could benefit from further research: off-chain asset linkages, decentralized adaptation, and legal standing.

Off-Chain Asset Linkages. As digital entities, blockchains depend on external interfaces to the offline world, including links to individuals (i.e. identity) and offline assets (e.g. physical property and goods). For example, a blockchain can provide proof of an event – such as work performed, content viewed, or payments sent – but it cannot guarantee *who* or *what* performed the action (Tucker & Catalini, 2018). This issue is partially a technical one – as technology such as GPS devices or sensors are increasingly easy to deploy to automatically and reliably record offline signals – but predominantly an organizational one. We encourage research on how existing organizations can use trust that they have established both internally and externally to complement the technology, and similarly how relational contracts can be used together with cryptography and incentives to create more robust organizations. Furthermore, it will be useful to understand how the technology changes the nature of organizations that act as intermediaries, and what types of new intermediaries will be needed as the space evolves.

Decentralized Adaptation. The blockchain form, especially when permissionless, requires faith in the reliability and security of the underlying code and incentives. When problems occur, they are difficult to address because in a truly distributed system coordination is slow, and in the case of a fork, inertia tends to favor the status quo. Furthermore, forks are not only costly to coordinate, but also have adverse welfare effects due to the incompatibility they introduce through fragmentation (Simcoe & Watson, 2017). Research is needed on what level of decentralization achieves the optimal balance between the inability to unilaterally change a system, and the opposite need to adapt to unforeseen circumstances in a timely and efficient manner. The blockchain form's transition from founder-centric or permissioned, to community-led and permissionless deserves particular attention, as it is the kind of organizational transformation that is likely to run into issues because of conflicting incentives between different stakeholders.

Legal Standing. Smart contracts are simply self-executing computer code and are thus neither a contract in the traditional sense, nor "smart" in the sense of being able to adapt to unprogrammed scenarios. Hence, they are currently more of an interesting technology than a legal covenant, with serious challenges plaguing their practical use (e.g. last-mile issues, trustworthiness and unambiguousness of third-party oracles, etc.). With the technology evolving far more rapidly than the relevant laws, blockchain-based organizations face legal, tax and regulatory uncertainty. Research could explore how organizations cope with this uncertainty and adjust their internal structures in response. In particular, researchers could study how relational contracts and other informal arrangements can be used to complement rules embedded in the code, and how this interacts with different regulatory environments.

9. Conclusions

This paper describes how blockchain technology opens new organizational opportunities and trade-offs that fall outside of the continuum between markets and firms, thus forming a discrete structural alternative. A key aspect of the technology is the ability to establish new types of digital property rights on assets, digital resources and content, which can then be stored and traded without a centralized custodian or intermediary. While the blockchain form is novel when permissionless, achieving this ideal requires a bona fide governance transition, not merely a "decentralization theatre", and thus may often fail to be achieved. We also emphasized how the theoretical possibilities of the technology are constrained by implementation challenges, and the comparative rigidity of the blockchain's governance structure once ownership becomes truly distributed. While permissionless blockchain organizations can benefit from the effort of many entrepreneurs searching the landscape for successful applications, they are slow to evolve. The nature and salience of these risks, as compared to the benefits from decreased trust in a centralized third-party, will influence each blockchain form's degree of decentralization. This transition in governance is the key organizational challenge for blockchain-based organizations and offers fruitful research opportunities for organization scholars.

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