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Socio-Technical Futures: A Blockchain Technology Assessment

A dissertation submitted in partial satisfaction of the

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in Global Studies

by

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[Thank you to my wonderful husband Ben Manski. Thank you to my committee members. I dedicate this manuscript to my three boys, Lev, Isaac, Grant and future generations who will imagine how to employ technology in ways that are beneficial for all life on Earth.]

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Manski, Sarah G. (2017). Building the Blockchain World: Technological Commonwealth or Just More of the Same? *Strategic Change,* (5)26.

PRESENTATIONS

"Distributed Ledger Technologies (Blockchains) and the Sociotechnical Imaginary" Society for the Advancement of Socio-Economics. The New School, NYC. 2019.

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"No Gods, No Masters, No Coders? The Future of Sovereignty in a Blockchain World" American Sociological Association (ASA) Annual Meeting. Philadelphia, PA. 2018.

"No Gods, No Masters, No Coders? The Future of Sovereignty in a Blockchain World" American Sociological Association (ASA) Media Sociology PreConference. Philadelphia, PA. 2018.

"Chain Technologies: Materiality, Agency, and Innovation" UCI Technology, Law and Society Summer Institute. UC Irvine, CA. 2018.

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"No Gods, No Masters, No Coders? The Future of Sovereignty in a Blockchain World" Sixth Annual Conference on Governance of Emerging Technologies and Science: Law, Policy, and Ethics. Arizona State University. Sandra Day O'Connor College of Law. 2018.
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"The Blockchain World: Explaining a Technological Revolution in Real-Time" American Sociological Association (ASA) Annual Meeting. Montréal. 2017.
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"Building the Blockchain: The Co-Construction of a Global Commonwealth" 12th Annual California Graduate Student Conference. University of California, Irvine. 2016.

MASTERS THESIS

Uncertainty and the Adoption of Environmental Business Practices. University of Wisconsin at Madison. 2009. My thesis research examined methods used by businesses to communicate their environmental policies and products, the use of the USDA Organic Label and other eco-labels, local farm-to-business partnerships, the growth of cooperatives, and the greening of the U.S. economy and global supply chains. This research identified several areas of friction in constructing, maintaining, and promoting sustainable global supply chains. I found that online technology could assist in the implementation of sustainable supply chain business practices.

TEACHING EXPERIENCE

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COURSES TAUGHT AS THE SOLE INSTRUCTOR

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HONORS AND ACADEMIC AWARDS

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The University of Wisconsin at Madison Advanced Opportunity Fellowship. Advanced Opportunity Fellowships are intended to support the recruitment and retention of highly qualified underrepresented students at UW-Madison. 2006-2009.
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low-income and/or underrepresented students in Ph.D. programs, and ultimately, to diversify the faculty in colleges and universities across the country. 1999-2002.
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AFFILIATIONS

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ABSTRACT

Socio-Technical Futures: A Blockchain Technology Assessment

by

Sarah Grace Manski

How do distributed ledger technologies, blockchain and post-blockchain systems, shape visions of the future, and how do these visions in turn influence the construction of new technologies? This question is global in nature as technologies and the technologists who create them are working within networks that defy geographic boundaries. Similarly, this research builds upon the work of scholars in several disciplines outside of global studies, including anthropology, sociology, economics, organizational studies, STS, and critical accounting. I make interdisciplinary use of theories of materiality, organization, accounting, agency, innovation, gender, and social movements to comparatively analyze how distributed ledgers are contributing to global political economic change, and toward what end. My research examines the political economy of distributed ledger technologies through ethnographic interviews (Appendix 3), future scenario building and discourse analysis. In the process, I grapple with the methodological challenges posed by studying global socio-technological changes in real time. My dissertation thesis includes chapters on an emergent technological commonwealth, applications of blockchain technology, positive and negative implications for sovereignty in blockchain-based futures, gendered technology, new forms of value accounting, and competing socio-technical imaginaries. Each chapter focuses on an aspect of the complex interaction between emergent

technology, infrastructures, human behavior and imagination. A particular contribution of my research shows how technologists, cooperatives, and ordinary people are working together toward the creation of a post-capitalist 'technological commonwealth' enacted with advanced exchange, communication, and governance technologies. I identify the affordances of distributed ledger technology that open up new possibilities of organization, cooperation and governance. However, the technologies enable more than one possible future and my research makes clear there are competing versions of the future being constructed at this moment. Which world is birthed will be articulated in the conjuncture of technological agency *and social movements*. Whether, individuals, nation-states, corporations, technologists or communities are empowered will depend heavily on the design choices that are made in the next few years and on the path dependencies, and political dimensions of the policies, practices, applications, and institutions created surrounding this technology. A strong alliance is necessary between technologists and the commons movement to build the next system beyond capitalism.

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I. Introduction

We do not live in an era of change, but in a change of eras. (Rotmans, 2014).

Technology is fundamentally reshaping every part of our lives. Literally and figuratively recircuiting our interactions with others, how we work, play, learn and imagine the future. Technology has driven our interconnectedness to a global level which has expanded the possibilities for political, social and economic structural redesigns. In this dissertation I was faced with the question, how should a global studies scholar approach the study of socio-technological change? To answer this question, I use an interdisciplinary theoretical basis for my research, including, theories of technology, materiality, agency, innovation, economics, accounting and value, together with social change and social movement theories. I bring this body of research into engagement with emergent technologies and the technologists who embrace them and ask: Are distributed ledger technologies contributing in a significant way to a shift in the global political economy, and if so, how are they doing that and to what ends?

The study of emergent chain technology and technologists has mainly been the province of computer science, economics, and organization studies. Only in the past three years has chain technology become a topic of expanded academic inquiry, and as of yet, few global studies scholars have studied these technologies. Because chain technologies are qualitatively global, they should be of special interest to those studying global processes and structures.

Revolutionary technologies present several problems for researchers, and this Ph.D. student is no different. Technologically driven social change far exceeds the pace of conventional policy formation and implementation. Therefore, one cannot merely examine the changes in traditional governmental and legal structures. This is true in part because emergent technologies produce

insufficient empirical data from which to derive recommendations for social policy. These research and policymaking problems stem to a significant degree from assumptions originating in positivist logic that prioritize the empirical and pretend ignorance of forces that may be unavailable for direct measurement (Bhaskar, 2008).

Furthermore, these problems are compounded by the realization that different technologies possess different powers for social transformation, and historical comparisons of technological revolutions are especially fraught. Altogether, these problems can produce social scientific paralysis in the face of contemporaneous technological revolutions, relegating such study to the popular literature. As social scientists committed to science in the public interest, we cannot afford to let this happen.

There is no one term for this new set of social and material relationships emergent from distributed ledger technology. Blockchains and their companion technologies are enabling a general wave of critical infrastructure decentralization within industrial production; Web 3.0 being the most prominent. The new nature of value as it flows through financial, service, and national infrastructure is yet to be determined. Already, the pace of technological change may have moved beyond what society can healthfully absorb, leaving people extremely disoriented as new social, organizational forms rapidly emerge, but before these forms are fully mature as a culture, they give way to the next set of techno-cultural formations (Toffler, 1984). It has long been understood that hierarchical social orders can be destabilized both by economic collapse and through the accrual of sudden economic wealth (Durkheim, 1897). Thus, if the past can be used to imagine the future, our global future will likely be experienced as an accelerating period of constant disorientation - political, institutional, economic, and social change.

Technology studies must play a crucial role in global studies scholarship and research because technology is an important driver of structural change. Drawing on a critical global studies perspective (Appelbaum & Robinson, 2005), I intend to explore how blockchain technology could play both positive and negative roles in shaping the future. Blockchains have three main qualities; they are a ledger of transactions of digital assets; the ledger is widely distributed among stakeholders/maintainers; the information contained on the blockchain is encrypted into transactions stored in ‘blocks' of data linked chronologically together. The first blockchain was Bitcoin with several cryptocurrency blockchains soon following Bitcoin's creation. However, currencies and tokens are only one small set of applications of blockchain technology; others include payment processing, online voting, humanitarian aid, copyright protection, cooperative exchange, digital identity management and supply chain verification. The democratic promise of blockchains resides in their tendencies toward decentralization and horizontalism. Some blockchain applications allow for the democratization of finance, services, agriculture, and governance without traditional geographic limitations (Manski, 2017).

Because blockchain technology was only invented ten years ago, and most blockchain-based applications are still in their ‘alpha' phase, blockchain technology should be considered contested terrain. Although Michael Messner (1988) originally used the concept of contested terrain to study sports culture, it is a useful theoretical framework for examining technology as cultural practices that reinforce both existing power dynamics and social inequalities and the agency of groups and individuals. There is a struggle going on right now between those using blockchain technologies as a means of resistance to global capitalism and those state officials and transnational capitalists who are using blockchain technologies to attempt to consolidate their power and wealth.

My research is designed to rethink how various actors use distributed ledger technology to drive social change. To do this, I expect to use comparative, historical, interpretive, and statistical methods to learn how technologists, cooperatives, and ordinary people may successfully participate in the creation of a 'technological commonwealth,' enacted through the use of the advanced exchange, communication, and governance technologies (Manski, 2017; Manski & Manski, 2018).

Agency

The social and material worlds engage in the process of co-construction. This is important when attempting to understand technology because actors demonstrate agency by producing and reproducing the material dimensions of institutions and that materiality, in turn, serves to direct the production and reproduction of the social dimensions of institutions. This is a process of evolution between the social and material; between humans and technology. We view the world through our individual or collective interpretative frames. In the field of Anthropology, (Geertz, 1973; Douglas, 1986; Stathern, 1999) discuss the issue of 'material culture.' In the field of philosophy, Ludwig Wittgenstein (1973) discussed how human language is rooted in the material world. Cognitive scientists (Hutchins, 1995; Suchman, 1988) suggest certain tasks can only be completed when the cognitive capacities of humans are distributed between assemblages of machines and humans together in 'situated action.'

Technology is always a combination of the technical, political, social, and economic. A technological institution can be defined as a technology that creates sets of rules that order reproducible social practices and actions (Jepperson, 1991). Technologies contain tendencies that are materially inherent, and technology is a structured set of relations that enables or constrains

different sets of possibilities. This is true because technology's form ‘calls forth' or enables or constrains different human actions. Some scholars of technology would disagree and argue that social context produces the entire meaning (and therefore, application) of technology. However, I believe the creators of technology explicitly and implicitly make thousands of value judgments in the design process about how and why a particular technology should be used. What properties are incorporated into a particular technology are determined through a process of negotiation between parties (Bijker, 1995). The actors involved in the design process have different levels of power and different interests in seeing different problems solved (Callon, 1991; Pinch, 1996). These decisions are communicated through the design of technology. In the digital realm, these choices become even more accessible because we can read the code (Leonardi, Nardi, & Kallinikos, 2013).

Technological objects are socially constructed (Berger & Luckmann, 1966). Mohr and Duquenne (1997) and Friedland and Alford (1991) call for an abandonment of the dualism of culture and practice or ideology and the material world. Trevor Pinch (2008) takes this further with a direct call for the integration of the sociology of technology with the broader field of social sciences. Pinch says, “an understanding of technology and indeed the material world, in general, could be an integral part of the building blocks of sociology” (2008, p. 469). His method for understanding the ‘black box of technology' is, in this instance, a historical case study of the emergence of music synthesizer technology.

The term sociomateriality is used because it implies that *all* social action is material (Kaplan, 2001; D'Adderio, 2011). “Whereas materiality might be a property of a technology, sociomateriality represents that enactment of a particular set of activities that meld materiality with institutions, norms, discourses, and all other phenomena we typically define as ‘social.’”

(Leonardi, 2012, p.34). Orlikowski (2007) argued that what was most important about technology was how it was put into practice by users. The term 'practice' is an arena in which social activities are collectively negotiated (Bourdieu, 1977; Giddens, 1984; Lave, 1988), leading to a necessary discussion of agency.

What do we mean when we use the term agency? Who or what has agency? It is useful to separate out the human component and think regarding social or human agency and material agency. Human agency is often defined as the ability to have goals and take actions to achieve those goals (Giddens, 1984; Emirbayer & Mische, 1998; Bourdeau & Robey, 2005). Taken to the level of the group, social agency is a group's coordinated formation and realization of goals (Pickering, 2001). Weber (1947) speaks of agency instrumentally, as intentional action conducted towards the fulfillment of goals. Habermas' (1984) view of agency or ‘communicative actions' differs in that the focus is on individuals who are interacting in a social context to achieve mutual understanding through a shared common interpretation of their situation.

It is challenging for some to offer agency to technology, but in the case of material agency, it is meant merely that the above-mentioned materiality of technology will call forth specific uses and afford it the ability to act absent sustained human interaction (Pickering, 1995; Kaptelinin & Nardi, 2006; Leonardi, 2012; Robey et al., 2012). Whereas materiality refers to properties of the object, material agency refers to the way the object acts when humans provoke it and how the object acts to provoke specific provocations by a human. The most useful way to think about the combination of material and social agency is Leonardi's use of the metaphor of imbrication (2011). By using the term imbrication, Leonardi is describing how the technological and social interlock to form a coherent organizational structure. He points out that people's goals are often constrained by what they think is possible using technology. Leonardi (2011) expands the

definition of practice as "the space in which social and material agencies are imbricated with each other and, through their distinct forms of imbrication, produce those empirically observable entities which we call “technologies” and “organizations.” (p. 38).

Blockchain technology is in the early stages of prescribing the entire global economy and the social practices between individuals, organizations, and other institutions. The world in which humans exist is composed of material things, and technology is an essential component of this materiality. Institutions, while certainly a construction of the social and cultural, are also in a substantial part material. The social and material worlds co-construct each other across time and in a globalized world across space. Technology fundamentally alters society and our institutions, and rapid technological change has often resulted in rapid institutional change, so the study of materiality and technology, in particular, should not be left to engineers or technocrats. Technologies do serve as institutions in and of themselves and exert agency as a matter of their design. The structural agency of a particular technology always plays a dual role in enabling and constraining new social relations.

Blockchain technology is unique in many respects, and it is also relatively flexible and can be used for a wide variety of applications. The material tendencies of blockchain technology are directly available in the blockchain code. I identified seven such tendencies (Box 1) for inclusion in another paper (Manski & Manski, 2018). I would point out blockchain technology's revolutionary character is evident in the presence of contradictory material tendencies.

Box 1: Seven tendencies of blockchain technology and the structural qualities that produce them.

1. **Verifiability:** Transactions are assured through encrypted network consensus mechanisms in such a form that all transactions from the very first to the most recent are recorded in a ledger open to its maintainers, reducing information asymmetries.
2. **Globality:** Digital transactions and cultural information flow transcend geographic space and national borders.
3. **Liquidity:** Value liquidity is enhanced as the location of a store of value that does not depend or under the direct control of a sovereign, central bank, or private corporation.
4. **Permanence:** The ledger of the transaction is immutable by design.
5. **Ethereality:** Transactions are conducted in a digital medium.
6. **Decentralization**: The ledger is widely distributed among many stakeholders and maintainers.
7. **Future Focus:** Found in newer developments of blockchain such as Ethereum, a stored autonomous self-reinforcing agency (SASRA) is formed in the temporal displacement of action through the use of smart contracts enabling the prefigurative recording of future transactions.[1]

Specific design features of technology demand new types of social arrangements (Winner, 1980; Beck, 1992; Castells, 1996). This agency is most potent in the early development of technology before standardization, and policy formation is baked into designs that create patterns of use and expectations in users (Adler, 1997; Schaffer, 1989; O'Connell, 1993). The freezing of technological possibilities through design standardization is called *phenomenotechnique* first by French philosopher Gaston Bachelard (Rheinberger, 2005) and later used by Bruno Latour and Steve Woolgar (1979). Pinch (2008) describes the important role of technological standardization, "Standards are rarely simply technical matters; they are powerful ways of bringing a resolution to debates that might encompass different social meanings of a

[1] Smart contracts allow for self-executing transactions to occur once specified conditions are met, such as inheritance money is transferred to a bank account after a certain date (i.e. daughter turns 21).

technology." (p. 472). Additionally, the less visible an institution is, the more power it contains because "social choices appear to have vanished from technologies, or are so deeply embedded within technical structures that they become invisible to all but the technical experts, that technologies are powerful institutions." (Pinch, 2008, p. 467).

We can already see early examples of phenomenotechnique occurring with blockchain technology. On March 13, 2017, the Delaware Corporate Law Council, as part of the Delaware Blockchain Initiative, proposed amendments to the DGCL that would allow corporations incorporated in the state to use "networks of electronic databases (such as distributed ledgers) to create and administer corporate records" (Markell, 2016). On August 1, 2017, Delaware became the first state to allow companies to start issuing and tracking shares on a distributed ledger or Blockchain. Stanford University launched a bitcoin and cryptocurrencies course (Althauser, 2017), and the University of California, Berkeley, and the Massachusetts Institute of Technology are offering similar courses (Coggine, 2017). Moreover, Treasury Secretary Steven Mnuchin is organizing a coordinated response by U.S. federal government agencies to blockchain technology (Cheng, 2018).

A. Description of Blockchain Technology

A blockchain is a distributed ledger database. Blockchains use cryptography to provide a decentralized multi-version consensus control mechanism to secure transactions in competing environments, without trusted third parties (Tapscott & Tapscott, 2016). Blockchains are different from traditional online database technology, wherein a central database is situated in a single location and accessed by a network of users. Instead, blockchains reverse this relationship. Each blockchain is a decentralized database distributed across a network of users.

In material terms, this means that each blockchain is simultaneously stored on computers throughout the network. Each transaction contains its own proofs of validity and authorization, eliminating the need for centralized verification (Tapscott & Tapscott, 2016). Thus, blockchain users do not need to know each other to rely on the validity of their transactions. This process, according to the inventor of Bitcoin, Satoshi Nakamoto (2008), works because the blockchain uses a consensus mechanism to ensure the integrity of the chain, whereby multiple nodes independently verify transactions between individuals.

Blockchain technology is in its infancy, and there are significant hurdles to commercial adoption. These can be seen with the first and most widely used application of blockchain distributed ledger technology, the cryptocurrency Bitcoin (Tapscott & Tapscott, 2016). In its first ten years, Bitcoin is facing expanding technological challenges because there has been a significant increase in mining costs, the average block size, price volatility, median confirmation time, mempool transaction count, and user fees. Bitcoin transactions are grouped together in 'blocks', hence the name 'blockchain'. Each block is protected with encryption, which include increasingly difficult math computation. Computer processing power is put to work as multiple computers compete to decrypt each Bitcoin block of transactions. This process is called 'mining'. The aggregate size in bytes of transactions waiting to be confirmed is the 'mempool transaction count', and the time it takes to validate Bitcoin transactions is the 'median confirmation time'. Users of Bitcoin pay a fee. For example, a popular exchange called Coinbase may charge a flat fee of $2.99 or a variable percentage fee of 1.49% of the total transaction amount. The average Bitcoin transaction fee outside of an exchange as of June 2020 is $5.53 per

transaction[2]. The Bitcoin block size is fixed at 1MB, so miners are only able to validate 1MB worth of transactions every ten minutes. The mining computer that wins this decryption race is rewarded with Bitcoin currency (the amount decreases over time to control the circulation of new tokens). Currently, the validation of Bitcoin transactions is extremely expensive concerning the aggregate energy costs of miners. The total energy consumption of Bitcoin mining is comparable with Ireland's total electricity usage, and this amount is projected to vastly increase when Bitcoin scales up (O'Dwyer & Malone, 2014).

Additionally, increasing usership is causing blocks to reach their current maximum size limit of 1 megabyte with more frequency (Torpey, 2017). Furthermore, the time and memory it takes to confirm transactions are increasing. It takes approximately 10 minutes to confirm a Bitcoin transaction, and this confirmation time will expand as more users enter the network (Torpey, 2017). Many coders are working on technological fixes to the validation problems of increasing time and energy consumption, such as the elimination of transaction malleability[3] and the entrance of two-layer solutions[4] (Young, 2017).

Blockchain maintenance does not, in every case, require massive consumption of electricity because there are different types of maintenance structures, including Proof of Work, Proof of Stake, Proof of Cooperation, and others. For example, the FairCoin (2016) whitepaper describes Proof of Cooperation, "(PoC) is the unique consensus algorithm developed for FairCoin. In contrast to other cryptocurrencies FairCoin does not implement any mining or minting

[2] To calculate determine size of a transaction in bytes, multiply it by the median byte size, take the answer in satoshis, divide it by 100 million (or 1e8 on a scientific calculator), get the answer in bitcoin and then convert to USD.
[3] Transaction mutability is when a digital signature can be changed before the transaction is put into a block. This problematic because the Bitcoin network is organized around these identifiers.
[4] Two-layer solutions operate on top of the Bitcoin ledger, ex. Lightning Network which creates double-signed transactions.

functionality, which are only needed for competitive systems. Instead, so called 'Collaboratively Validated Nodes' (CVNs) cooperate to create new blocks and to secure the network… The consensus rules determine which CVN has to create the next block. Each CVN approves that CVN by digitally signing a piece of data which contains its unique ID. After the respective CVN has received all the necessary signatures, it takes pending transactions and forms a new block which is then stored in the immutable and distributed blockchain database." Choosing specific maintenance models over others reify different economic logic. There are also different economic models associated with blockchain technology, such as a buy-in economy (where you can exchange dollars for cryptocurrency) versus a work-in economy (where you can earn cryptocurrency through work that contributes to the network). An example of a buy-in economy would be Bitcoin's use as a store of value where users must convert fiat currency to the blockchain's operating token (BTC) and face increasing transaction fees. An example of a work-in an economy is Steemit, which is a social impact economy where work performed is ranked by merely letting community members vote on which actions are in most demand, such as 'upvoting' a blog post they like. Of course, other chain technologies are competing with blockchain for mainstream global adoption.

1. Smart Contracts and DAOs

Another important area of inquiry is "smart contracts" - systems that automatically move digital assets according to arbitrary pre-specified rules. The logical extension of this is decentralized autonomous organizations (DAOs) - long-term smart contracts that contain the assets and encode the bylaws of an entire organization. Blockchain technologies generally, and DAOs specifically, promise an enormous expansion of corporate agency. This is especially relevant in a period in which the United States is still coming to terms with the US Supreme

Court's direct embrace of corporate constitutional personhood via its rulings in *Citizens United* and *Hobby Lobby*. As a self-directed corporate code, and compared with earlier corporate forms, DAOs operating on blockchains have the potential to exercise significant autonomy from both regulatory oversight and direct human control, and thus a form of corporate sovereignty. In these respects, DAOs might be thought of as one of the next evolutionary branches of the corporation.

The essence of the corporation throughout its history can be understood as an expression of the relation of self-organized people and the state (Manski, 2006). In Western societies, contests over the forms, duties, and powers of corporate officers and corporations themselves have been critical in the trajectories of expansionist societies, from the *colegium* and *pater familia* of Ancient Rome, through the growth of the Roman Catholic Church, the European conquests and colonization of the Americas, Africa, and Asia, and resistance to the British East India Company in the early days of the American Revolution. Beginning in the late nineteenth century and developing through the late twentieth and early twenty-first centuries, public concern over corporate personhood and corporate power has grown, to the point that in the United States, a majority of the population lives in jurisdictions that have voted that "corporations are not people and money is not speech" (Manski, 2017). The nationwide total of passed referendums equals 820[5].

As interest in the creation of DAOs continues (Hertig, 2017), we face the possibility that DAO firms will exercise state protection in the form of both constitutional and global trade rights. Therefore, serious questions should arise about the relation of DAOs to people and the state. For example, today, many corporations hire paramilitary groups to protect resource extraction, production, and transportation sites (O'Connell, 2016). Chiquita Brands

[5] This effort led by Move to Amend, a national volunteer-led operation that started organizing around money-in-politics reforms shortly after the Supreme Court's 2010 Citizen's United decision.

International paid a $25 million fine after admitting it hired terrorists in Colombia from 1997 to 2004 (AP, 2007). Which individuals will be held responsible when a DAO smart contract engages in similar behavior? Another case is that of money in politics. Campaign finance laws intended to preserve elections as a forum open to the many members of a particular polity are not equipped to deal with DAO interventions; indeed, the US Federal Election Commission is only beginning to come to terms with the existence of Bitcoin. The third set of problems involves the absence of human reflexivity in self-executing smart contracts. A DAO may be useful in achieving particular pre-determined outcomes, but individual DAOs do not have the same interests as their creators, never mind others. To paraphrase Justice Stevens of the US Supreme Court, corporations "have no consciences, no beliefs, no feelings, no thoughts, no desires… [and] are not themselves members of 'We the People' by whom and for whom our Constitution was established" (*Citizens United v. FEC*, 2010).

B. The Emerging Blockchain Economy

It is already evident that the transformative potentials of blockchain technologies, however, implemented, are generating significant interest. US federal agencies, including the NSF, DARPA, and DHS, have awarded over $8 million to small businesses and universities for blockchain-based research. Venture capitalists have invested $ 3.078 billion in blockchain startups (CBINSIGHTS, 2019). At the January 2016 World Economic Forum, sessions on technology-enabled automation, including blockchain, were tagged with the phrase *Fourth Industrial Revolution*, describing the economic fusion of technologies blurring the distinctions between the physical, digital, and biological spheres (Schwab, 2016).

Major powers such as China, Russia, Japan, and the United States, and small countries like Uruguay, Slovenia, and Kenya, are all jockeying for comparative strategic advantage in the

development and deployment of blockchain technologies (Tapscott & Tapscott, 2016). For instance, the US state of Delaware is working with developers at Symbiont to archive, catalog, and cryptographically secure government records on a blockchain for the Delaware Public Archives. Delaware officials are also exploring modifications to Delaware corporate law to enable the authorization of distributed ledger shares by Delaware corporations (Dworkin, 2016). Executives at the National Bank of Canada, in collaboration with the country's largest banks, are using blockchain technology to develop an electronic version of the Canadian dollar (Stafford, 2016). The Tunisian government is partnering with Monetas and DigitUs to replace its self-created eDinar digital currency with a blockchain-based version allowing La Poste Tunisienne customers to issue remittances, instant money transfers, and purchases in-store and online via QR codes (Caffyn, 2015). Japanese banks are planning the creation of a blockchain currency exchange (Higgins, 2016).

Just as major financial institutions, government economic planners, and venture capitalists are motivated by the new possibilities to maximize institutional advantage using blockchains, so too are a growing movement of social entrepreneurs, cooperatives, and activists who are using blockchain technologies in pursuit of cooperative ownership and management of wealth, or a technological commonwealth. The purpose of a commonwealth is to develop "community economic institutions which are egalitarian and equitable in the traditional socialist sense and controlling productive resources for the benefit of all, but which can prevent centralization, and, which over time can permit new social relations capable of sustaining an ethic of individual responsibility and group cooperation which a larger vision must ultimately involve" (Alperovitz, 1972). Thus, a commonwealth might be thought of as an economic project that aggregates, distributes, and governs capital at multiple levels and on a cooperative basis. A

technological commonwealth is a commonwealth enacted through the use of advanced exchange, communication, and decision-making technologies.

This dissertation shows how various early innovators of blockchain technologies are using them to expand economic democracy and, in so doing, build the foundations for a technological commonwealth. Certain tendencies of blockchain technologies that may exhibit countervailing effects, including the strengthening of hierarchies, centralizing of power, and exacerbating inequalities, are also considered. Fred Block (2008) has argued that with conscious effort and attention, new technologies can be used to create a better future. In these first years of a blockchain world, a critical task of scholars of technology and society is the identification and evaluation of the variety of tendencies that blockchain technologies may exhibit. In doing so, we can begin to craft policies that guide toward desirable outcomes.

C. A Decentralizing Technology

Despite current technological challenges, developers have built an array of applications on blockchains. Some of these applications exhibit tendencies that lead toward a technological commonwealth and some toward a centralization of power and increasing inequality, whilst other tendencies are unclear as to which possible future they suggest. Those tendencies that suggest the emergence of a technological commonwealth include disintermediation, trustless exchange, increased user control of information and transactions, maintenance of high-quality, accurate data, durable decentralized networks that are difficult to hack, transparency, immutability, faster and less costly transactions (see Table 1). But other tendencies of blockchain technology either fail to suggest or actually contravene the construction of a technological commonwealth. These tendencies include unresolved technical challenges, an unsettled

regulatory environment, cyber security and privacy concerns, challenges to widespread user adoption, job loss due to automation, and decreased corporate accountability (see Table 2). All of these are discussed in further detail below, beginning with an examination of blockchain applications that tend toward the construction of a technological commonwealth in the financial, healthcare, identity, agriculture, governance, service, and supply chain sectors, and then turning to a consideration of blockchain tendencies countervailing against the commonwealth.

TABLE 1 Key tendencies of blockchain technology leading towards a technological commonwealth

Disintermediation	Trustless exchange	Increased user control of information	Durable, secure decentralized networks	Transparency and immutability	Maintenance of high-quality, accurate data
Increasing ability to monetize personal information, service improvement, and potential circumvention of centralized global financial capital	Increasing ability to cooperatively share value across borders	Issuance of data directly to members and improved ability to monetize personal data	Reduction in hacking theft or direct expropriation	Potential for the reduction of corruption and increasing incentives for ethical supply chain practices	Reduction of waste and product loss and improved utilization of equipment and inventory tracking

TABLE 2 Key tendencies of blockchain technology leading away from a technological commonwealth

Unresolved technical challenges	Unsettled regulatory environment	Cybersecurity and privacy concerns	Challenges to widespread adoption	Job loss due to automation	Decreased corporate accountability
Increasing mining costs, energy usage, average block size, median confirmation time, mempool transaction count, and user fees	Reduction in investment in new technologies	While blockchains themselves are very difficult to hack, the intermediary services are vulnerable	Limited user-friendliness and superior technical expertise required are acting as barriers to adoption	Many middle and lower-income workers in the areas of account-ing, verification, banking, and others may lose their livelihood	Companies may exploit the lack of regulation to engage in undesirable behavior and future DAOs may be difficult to control

Given the current limitations placed on democratic governance, one might wonder whether distributed ledger technology can provide the necessary infrastructure for a more decentralized society. To be sure, by eliminating the middleman, distributed ledger technology allows for people to cooperate in a more decentralized manner. It contains affordances to facilitate a more collaborative economy, yet current existing blockchain-based networks are often inconsistent with a conception of the collaborative economy defined as an economy based on "horizontal networks and democratic participation" (Botsman & Rogers, 2010).

Players in a collaborative economy must contribute towards building and validating trusted relationships between members of their communities (Hawlitschek et al., 2016). Accordingly, if the potential of blockchain technology is real, it is crucial to acknowledge the limits of existing attempts at adopting a market-driven approach to the governance of decentralized blockchain-based applications. In addition to the technical challenges that still have to be addressed by these emergent technologies, one of the main challenges that have yet to be addressed is how to avoid replicating gendered and racialized systems of oppression.

D. An Emergent Technological Commonwealth

The material agency of distributed ledger technology could enable the construction of self-sovereign identity'. The word sovereignty refers to "the receiving of a general recognition of exclusive domain and consequent possession of the capacity to establish the rules of conduct within a particular field of action" (Manski & Manski, 2018). We all have both offline and online identities. For anyone who uses digital systems, tied to our material identity are various digital identities. For the most part, these digital identities are not under our control, and often, we are not able to see what information is contained within each system. Problematically, if the information is incorrect, we do not have the ability to correct these errors, nor do we control what and with whom information is shared and sold. Self-sovereign infrastructure allows users to set the boundaries regarding who has access to their data and maintain their privacy. It can also reward users for being contributors. This infrastructure thus allows people to protect their autonomy while conducting joint work and collective action.

The cooperative movement is beginning to respond to these emergent identity issues, seeking to wrest control of personal data from major corporations and governments and to

provide privacy protection to individuals. Over the 1990s and 2000s, proponents of a democratic Internet developed platforms such as igc.org, Indymedia, and Drupal that were intended to provide an online commons free of corporate and government control and surveillance (Emerson, 2005). Today, enterprises such as uPort are creating blockchain applications that allow individuals to know what data is being collected about them, and to choose which identity information they want to share and monetize (ConsenSys, 2015).

Similarly, ShoCard and Cryptid use blockchain technology to store personal identification cards on an encrypted global network (ShoCard, 2017). From Locke and Rousseau to Dewey and Mouffe, democratic theory has long insisted that a functioning democracy is a better guarantor of individual rights, including privacy rights, than autocratic government (Locke, 1689; Mouffe, 2000; Rousseau, 1968; Westbrook, 1993). While initiatives like uPort and ShoCard are not formally a part of the cooperative movement, they operate in a similar spirit and show a way forward. The integration of such blockchain-based universal logins with democratic open-source platforms such as Drupal could allow for the construction of a cooperatively managed identity infrastructure that provides greater privacy protections than those offered by major corporations and state agencies.

Blockchain technologies are particularly useful for the cooperative movement in its long-term ambitions for a global commonwealth. For two centuries, the cooperative movement has been antagonistic to both corporate capitalism and state socialism on the basis that both systems rely on the concentration of economic and political power, and are; as a result, undemocratic, inefficient, and in the long run, unsustainable (Alperovitz, 1972; Curl, 2010). The desire to build an alternative to state-centered and corporate capitalist economic models has been a primary driver of the cooperative movement from its beginnings in the early nineteenth century

(Krimerman, 1992; Ness & Azzellini, 2011). Historically, cooperatives and associated labor, farmer, consumer, and democracy movements have sought to build commonwealth projects. Among the more notable of these projects were those associated with European utopian socialism (Marx, 1864; Thompson, 2011), North American progressive populism (Humphrey, 1891), Iberian syndicalism (Whyte & Whyte, 1991), and the Israeli kibbutzim (Kurland, 1947).

The cooperative movement today includes consumer and worker cooperatives, employee-owned companies, credit unions, community development loan funds, service credit systems, and local barter and service exchange networks (Lewis & Conaty, 2012). Globally, cooperatives comprise hundreds of millions of users, are valued in the trillions of dollars, and move products in almost every sector across global supply chains (DG Report, 2014). Cooperatives and the cooperative sector are deeply invested in strengthening their transnational ties and developing greater control over their global supply chains (Della Porta, 2006). Since 1966, the charter of the international cooperative movement, the Rochdale Principles, has asserted that "Co-operatives serve their members most effectively and strengthen the co-operative movement by working together through local, national, regional and international structures" (ICA, 2017).

As cooperatives seek solutions to the problems associated with working across boundaries and cultures, the capacity of blockchains to avoid hostile intermediaries and to solve trust issues in the exchange of value between geographically disparate users is critical. The use of blockchains enables multiple organizations to confidently and securely transfer value electronically without an intermediary such as a commercial bank. This is important because intermediaries may prevent entities with whom they disagree or are in competition from using their services. For instance, in India, the operations of 370 district cooperative central banks and 93,000 primary agricultural credit societies were severely impacted when commercial

banks refused to provide currency support following the demonetization of Indian banknotes by the Reserve Bank of India (Matthew, 2016). These kinds of problems have led the International Cooperative Alliance (ICA) to explore ways to use technology to expand the cooperative movement on a global scale to bring the "core and backbone of the co-operative model into our digital and virtual age" (ICA, 2017). The ICA and other transnational cooperative organizations make use of multiple technologies, including blockchains, to further democracy in every economic sector they are present, including insurance, housing, health, fisheries, consumer banking, agriculture, and much more (Alperovitz, 2012, 2013; Curl, 2009; Wright, 2014).

Certain sectors of the global economy are predicted to be impacted more quickly than others by the introduction of blockchain technology, particularly those industries that benefit from less centralized and more accelerated interconnectivity between different systems irrespective of geographical and physical space (Simonite, 2016). These sectors include finance and currency, healthcare, identity management, government services, security, and supply chain management. This article provides an examination of the uses of blockchain to strengthen cooperative management and ownership in these sectors, and the use of blockchains in the food and agricultural sectors, because agriculture has historically played a particularly significant role in the cooperative movement.

1. Fair.coop

> *For the first time in history, a combination of political awareness, weakness of the capitalist economy, and p2p cryptographic technology allow us to present serious and realistic alternatives to the current governing models. A global cooperative financial system gives us free and fair markets, a huge step forward. If this is*

combined with an unbreakable set of ethical values based on freedom and democratic decision-making protocols, it starts to become a visible reality. (Interview with Enric Duran, 2019).

Fair.coop founder, Enric Duran, stole 492,000 euros from Spanish banks in 2008 (Schneider, 2015) and set up the Catalan Integral Cooperative, a loose network of cooperative ventures with 2,500 members. In 2014, Duran purchased 10 million in an abandoned cryptocurrency called FairCoin, in order to have a cryptocurrency to accompany his new venture, Fair.coop[6]. The FairCoop ecosystem is made up of hubs, or 'local nodes,' in dozens of countries around the world.

Fair.coop is a global cooperative that is organizing for the comprehensive elimination of all institutions of capitalism and domination (Duran, 2017). Their strategy is centered on building the institutions of a new commons-based economic system to construct a circular economy outside of corporate capitalism. Up to the present moment, Fair.coop has achieved some of their goals including the creation of FairCoin an innovative, secure and ecological currency, the development of a growing global network of local organizational nodes, opened FreedomCoop a European cooperative framework, co-founded a cooperative Bank of the Commons, built an online marketplace (FairMarket) and a collaborative working platform.

2. P2P Foundation

Seemingly all roads in the global technological commonwealth lead back to The P2P Foundation, which is a global research hub and thinktank working to educate the public about

[6] For more information see https://en.wikipedia.org/wiki/Enric_Duran

commons-oriented peer to peer (P2P) opportunities and organize a network of scholars, activists, programmers, and organizations to build participatory production and governance processes. Blockchain technology's famous elusive creator, Satoshi Nakamoto, created a member page on the P2P Foundation's social network site (Nakamoto, 2009). The founder of the MetaCurrency Project, Arthur Brock, is a longtime author and member of the P2P Foundation (Brock, 2011) as well as Enric Duran, the founder of Fair.coop (Troncoso, 2014).

The ideas of the founder of the P2P Foundation, Michel Bauwens, have been incredibly influential. He published a widely read policy paper titled “Commons Transition Plan” (Bauwens, 2014) which, in part, described the strategic use of technology to replace capitalism with a global commons. The ‘commons’ is a concept that is deeply rooted in human history, and commons-based technology includes the free/open-source software movement; the free culture movement; open hardware; open access to education and science; physical production through open design; hacker/maker spaces and Fab-labs; and the sharing economy. Bauwens envisions five steps (running concurrently) in a strategy for achieving a commons-centric society,

> *Step one: we have cooperation around knowledge, software and design. Step two: we redistribute urban commons wherever possible (shared mobility, housing, etc..). Step three: we capitalize generative work and produce via systems of cosmo-locatization as we are already doing with organic food, energy coops and multi-factories. Step four: we engage in political mobilization for pro-commons policies, in the form of public-commons protocols and partner state developments, which demands the creation of assemblies and chambers of the commons, etc... Step five: we use new technologies - post-corporate vehicles and shared accounting/logistical tools to represent the new value streams - to create warm current-sees and circular finance protocols to fund the*

commons economy. (Interview with Michel Bauwens, 2019).

A subset of technologists inspired by the P2P Foundation is using chain technologies to build commonwealth institutions in what is commonly called the ‘sharing economy' (Arcidiacono & Podda, 2017). The sharing economy is “commonly envisaged as a new socio-economic model based on collaboration, access to, and the socialization of value production” (Arcidiacono, Gandini & Pais, 2018, p. 276). It is similar but different from the ‘global technological commonwealth,’ which is a ‘popular cooperative commonwealth’ enacted through the use of advanced exchange, communication, and governance technologies (Manski, 2017).

Within the sharing economy, technologists are building blockchain applications impacting workers, the environment, and governance. There are different types of ‘sharing’ in these applications; some are explicitly anti-capitalist, and some include more modest design goals. On the timid end of the sharing economy, the spectrum is so-called ‘sharing-in’ applications, which expand the number of people who can participate in a resource. On the cooperative side, there are ‘sharing-out’ applications designed to shift commodities to the commons (Belk, 2010; 2014). There is a split between those who believe a capitalist market-based determination of access to resources is acceptable in the sharing economy and those who are strongly opposed to the application of the term ‘sharing’ to describe economic behavior, “when a company is an intermediary between consumers who don't know each other” (Eckhardt & Bardhi, 2015). The P2P Foundation supports building blockchain applications beyond the logic of global capitalism.

It is interesting to note that globalization of the economy is presenting a frustrating paradox for communities working to transition to a post-capitalist economy because there is a vast disjuncture between a shared supportive culture and current economic and legal organizational

and institutional forms available. Current economic and legal organizational and institutional forms are embedded in capitalist economies, which means that most utopian organizations are dependent on corporate bank financing, stock market behaviors, hierarchical organizational cultures/management styles, and so forth. Additionally, many transitional cooperative models are challenged by their supply chain isolation and surrounding hyper-competitive markets. It is still unclear whether the new ethical sharing economy - which internalizes social and environmental externalities - or the dominant disaster capitalist extractive economy will see more significant benefits from blockchain technologies.

II. Blockchain Applications

A. Finance and Currency

In the financial sector, blockchain applications allow users to circumvent global financial capital and to self-organize on a cooperative basis. Blockchain finance applications offer users increased participation in controlling currency exchange, banking, land title rights, sustainability, and development. One example is the blockchain application Abra (meaning 'open'), designed to reduce the fees paid by users sending remittances. Blockchain applications like Abra are expressly intended to disrupt the $600 billion remittance industry. Abra charges users with no transfer fees, and 2% to add and withdraw money instead of the traditional 10%. Users access the application on a smartphone. Additionally, money sent via blockchain application can take minutes instead of the days or even weeks that traditional banks may take to clear an international exchange. The vision statement of Abra's developers makes their purpose clear:

> *To realize our vision of a free peer-to-peer money transfer network, we've been building a global ecosystem for person to person payments that works on any smartphone in any country in the world. While traditional remittance providers look at the world in terms of "corridors," we see the world as one big connected global network. Our blockchain based platform helps us realize that vision.* (Buntinx, 2016a).

B. Healthcare and Identity Management

In *Identity is the new money*, David Birch (2014) writes that every discussion about the blockchain boils down to identity issues. In the related sectors of healthcare and identity management, blockchain applications are serving to improve patient care and allow users of online technologies to exercise greater control over their personal information. Blockchain technology offers patients and healthcare institutions the ability to securely share patient identity and healthcare data across platforms. Being able to quickly and effectively diagnose patients should lead to more effective and cost-efficient treatments (Prisco, 2016). Health records could be secured with blockchain technology and made accessible to any hospital in the country simultaneously upon authorization by the patient or legal guardian. This could allow for the quick and effective diagnosis of patients and more cost-efficient treatments (Prisco, 2016). As an example, the Gem Health Network states,

> *We imagine a future where every patient holds the keys to their healthcare passport, bridging patient care among multiple providers, and across borders. We imagine hospitals hiring more doctors and nurses on a budget recovered from wasted reconciliation expenses. We imagine labs, wearables, shopping lists, and healthcare apps working together to inform a healthier population. We imagine a*

> *better quality of care for every patient, and easier, smarter systems for the providers that care for them.* (Vergel de Dios, 2016).

Another company, BlockchainHealth, is building a blockchain-enabled application that will allow users to share their health data with researchers while maintaining control of their sensitive personal health data (BlockchainHealth, 2017). Blockchain applications could, in the future, streamline the insurance claim process by automatically verifying and authorizing (or denying) treatment and coverage (Molteni, 2017).

The identity management tools offered by blockchain, which allow people to determine what and how much identity information they share, can be applied outside of the healthcare field as well. Service aggregators like Facebook collect significant quantities of personal data and resell this information. Corporations like Alphabet (Google) and Facebook already collect and monetize users' personal data, including consumer preferences, purchase history, friendships, travels, and more. Individual users are required to accept the terms of service and allow wide access to their personal data if they want to use many offerings (Havens, 2013). The central concentration of identity data collected by large corporations and governments attracts the attention of hackers who seek to steal this data and sell it or hold the owners to ransom. In exchange for the use of their services, corporations collect the personal data of users, which, in turn, they often sell to advertisers. Profits from the sale of personal information are not shared with the community of users providing this information, and some have argued for an expansion of the right of "publicity," which is a term used to describe the common-law right to control the commercial exploitation of one's personal identity (Wassom, 2016). A related set of issues involves the use of blockchains by health insurance entities to enforce payment responsibilities or by states to monitor the spending of social service monies. For instance,

following an announcement by the United Kingdom that it intended to engage in trial use of blockchains to distribute public assistance, concerns have emerged about the possibility of government auditing of all individual expenditures (Cellan-Jones, 2016).

C. Food and Farming

Members of the cooperative movement see food not merely as a commodity but as a multi-dimensional expression of culture and community, which should be cooperatively managed and owned (Hudson and Fridell, 2013; Patel, 2012). Former President of Costa Rica, Laura Chinchilla, praised cooperatives in a speech at the 2018 Food Agriculture Organization (FAO) for the UN, "[cooperatives] free people from hunger and poverty in a globalized world in which crises, including climate change, touch everyone" (Barker, 2012).

Blockchains assist in the expansion of cooperative agriculture by reducing collaboration and administration costs, including the collaborative design of which crops to grow, what land to plant, and what prices to set. In particular, smart property transactions through the use of blockchain smart contracts enable the shared use of farm equipment, tools, and transportation, and recurring purchases or automatic orders once a set price is met (Bodell, 2016). An example is AgriLedger, a blockchain application designed to help farmers retain a bigger share of their crop value by creating the world's largest communication network of small farmers and cooperatives (AgriLedger, 2017).

FarmShare is a promising application of blockchain technology that facilitates token-based equity shares, distributed consensus, and automated governance to foster greater community-to-farm-to- community engagement while eliminating some of the managerial burdens and business risks from farmers involved in a Community Supported Agriculture (CSA) farm

(Bodell, 2015). Traditional CSA farms are structured so that subscribers pay a set fee at the beginning of the growing season in exchange for the regular delivery of a portion of produce.

This is a shared risk structure. FarmShare community members receive FarmShare tokens created and distributed by each participating CSA. These tokens represent shares of the harvested crop and can be used to purchase produce. FarmShare developers' goals include establishing community engagement as a peer-to-peer network (FarmShare, 2016). Technology innovators in the cooperative agricultural sector imagine further steps on the road to commonwealth production. One visionary model involves the decentralization of farming to the household level through the utilization of blockchain-enabled *smartgrids* (Swan, 2015a). An example of a blockchain smartgrid in food production would be a community of individuals growing food at homes and businesses networked via a blockchain application. Each member in a blockchain farm smartgrid would use a portable hydroponic unit to grow food for both their own and community consumption. A map would allow users to find local hydroponic units with fresh produce in an on-demand real-time updating reservation-taking system. Consumers would own shares or tokens supporting local food cooperatives. They could purchase these tokens directly or receive them through volunteer or educational activity. Filament is a company producing low-power hardware GPS nodes, which connect farm machinery and industrial infrastructure to the blockchain network. The company claims that farmers will be able to reduce costs by using the blockchain-enabled GPS nodes to keep tabs on the location of mobile equipment and the functioning of fixed machinery, even in remote areas (Filament, 2017).

D. Governance and Organization

Humanity is in the midst of a transition, which will likely kill all of us unless we upgrade our individual and collective capacity for thought and action. (Interview with Jordan Greenhall, Neurohacker Collective Co-Founder (Schmachtenberger, 2018)).

Blockchains are increasingly being used to democratize functions and governance processes of the state, as well as, in some cases, to relocate traditional state functions into the cooperative (as opposed to private) sector. Specific innovations range from collaborative governance voting systems and public financing crowdfunding systems to transparent tracking of state spending and voter-based monitoring of election integrity (Swan, 2015b).

Few functions are as central to state legitimacy as the allocation of property rights, but even here, we see growing adoption of blockchain by state authorities to regulate land titles. Government officials in the Republic of Georgia are partnering with BitFury to design and pilot a blockchain land titling project that would place ownership rights on an encrypted public database, thereby allowing users to maintain a valid title to their land, enabling them to borrow against it, and plan for the future (Shin, 2016). Similarly, the Swedish government began testing its land registry in March 2017. They are working with blockchain startup ChromaWay and two banks that specialize in mortgages, Landshypotek, and SBAB (Rizzo, 2017).

Some blockchain applications have been built with the purpose of supplanting nation-states entirely. Bitnation is a blockchain project designed to decentralize institutional governance power on a global scale by eliminating geographic limitations to citizenship (Tempelhof and Teissonniere, 2017).

Well, I think citizenship should be abolished altogether really. The problem with a nation-state is that it's not global and it's not local right? It's like 200 geographical

> *areas, literally 200, and none of them are either particularly local or particularly global. Everyone should be able to create their own nation, everyone should be able to create their own reality, both global and local.* (Interview with Susanne Tarkowski Tempelhof, 2019).

Bitnation is structured as a *holacracy* (Tempelhof & Teissonniere, 2017), a cooperative organizational form that removes power from central management and distributes it across members of self-organizing teams (Robinson, 2015). Thus, Bitnation aspires to provide much of the political-legal infrastructure required in the construction of the political economy of a technological commonwealth. Bitnation's initial projects include offering blockchain IDs and Bitcoin Visa debit cards to refugees to receive funds from their family in the absence of a bank account. In December 2015, the Estonian government partnered with Bitnation to offer a blockchain public notary to e-residents, enabling the notarization of their marriages, birth certificates, land titles, and business contracts on the blockchain (Allison, 2016).

Technology enables a new kind of cultural fantasy, art, myth, and ritual to enter the realm of the internet (Appadurai, 1999). This complicates the relationship between individual and collective national experience. The new global economy is causing older binary models like center v. periphery to become obsolete and challenging researchers to imagine a new spatialization of the global economy regarding flows. A new global systems analysis is necessary because the planet is composed of a growing number of rapidly changing phenomena. Was Giddens (1984) correct when he wrote that globalization is reflexive modernity? The world is a global system, but nation-states do continue to play the dominant role in the organization of social life.

Will the widespread adoption of blockchain technologies for currency and other instruments of interaction and communication, undercut the authority of the nation-state or will blockchain technology be used by the nation-states to strengthen national institutions? Bitcoin and cryptocurrency detractors would like the U.S. government “to regulate it out of existence” (Nicolaci da Costa, 2018) and require currency exchanges to turn over user information (Paul, 2018) to federal authorities. There is a movement by the U.S. government to restrict blockchain technology's potential, and officials are criminally investigating initial coin offerings (or "ICOs") (De, 2018) and placing capital gains taxes on blockchain token trading (Bernard, 2018). Under the Trump Administration, both nation-state (Venezuela's Petro cryptocurrency) and non-state cryptocurrencies are being criminalized (Iyer & Anand, 2018), and yet all nation-states are at the same time scrambling to incorporate blockchain technology into national systems in a manner that will give them a comparative strategic advantage over their rivals (Tapscott and Tapscott, 2016).

David Redl, the assistant secretary for communications and information and an NTIA administrator, commented, “We expect that in the coming years, our focus will increasingly be on artificial intelligence, automated workforces, blockchain technologies and more” (Redl, 2018). The NTIA is a part of the U.S. Department of Commerce, which has been publicly discussing blockchain technology since 2016 (NTIA, 2016). The acronym NTIA stands for the National Telecommunications and Information Administration, and on June 4th, 2018, the agency announced that it is seeking stakeholders' input in “shaping its international agenda.” Broadly about internet governance, that agenda is set to pay specific attention to “emerging technologies and trends” such as blockchain, as well as freedom of information online, privacy and security. Cryptocurrencies are the most advanced use of blockchain technology, and a report

written by Andrew Nelson (2018) on the state of world regulation of cryptocurrency found that there is little international cooperation regarding the standardization of cryptocurrency regulation. Because of its dominance, what seems likely to happen is the U.S. government will create a virtual currency and blockchain technology legal framework that will likely be adopted by the rest of the world.

As described earlier, blockchain technology's multiple affordances (Box 1) give it the versatility to become transformative in many nation-state institutions such as financial markets and credit, shipping, e-commerce, health and education, supply chain management, public infrastructure projects, identification and insurance, remittances, national and independent currencies, automation, policy-making and voting and more. Applications are being developed that could, in each sector, increase efficiency, improve the exchange of information, maintain data resilience, and reduce corruption.

National Currencies

The average daily volume and value of U.S. payment, clearing, and settlement (PCS) processes, is approximately 600 million transactions per day, with a valuation of over $12.6 trillion (Bank for International Settlements, 2015). Some of the benefits of blockchain technology for national currencies are that they could improve end-to-end settlement speed, data auditability, resilience, and cost-efficiency. In 2016 the central banking system of the United States, the Federal Reserve Board, issued a report on blockchain technology's potential impact on currency payments and settlement “to identify both the opportunities and challenges facing its practical implementation and possible long-term adoption” because they have a “public policy

interest in understanding and monitoring the development of innovations that could affect the structural design and functioning of financial markets." (Mills et al., 2016).

National Defense and War

Air Force Major, Neil Barnas, wrote a report (2016) on blockchain technology's impact on US National Defense, in particular, the national government's ability to defend digital data and systems, from manipulation and compromise. The report concludes that the US Air Force should leverage blockchain's cryptographic protection and fault tolerance for national defense purposes.

Governance and Administration

The industry advisory group, the American Council for Technology, issued a report (2017) on how the US Federal Government might use blockchain technology to improve governance. They argue that blockchain technology could improve constituent engagement, voting, financial transactions, tax collection, identity and benefits management, vendor tracking, regulatory compliance, and disaster recovery. Blockchain's automation of accounting, verification, and contract fulfillment has the potential to help the government reduce fraud, save paper, and enable collaboration across multiple divisions and agencies. Moreover, the adoption of blockchain may also allow government agencies to provide new value-added services to businesses and others, which can generate new sources of revenue for these agencies.

However, blockchain technology could be used to increase the security state's practices of monitoring and surveillance of citizens. Blockchain technology could be combined with the Internet of Things (IoT) technology and artificial intelligence to get the national government's greater ability to monitor the movements and communication of citizens. Edward Snowden and

journalists at The Intercept revealed (2018) that the US National Security Agency (NSA) created a secret counter-terrorism and internet surveillance operation, code name OAKSTAR, which pulls data directly from the fiber optic connections that form the internet undergird to locate senders and receivers of Bitcoin and other cryptocurrencies around the world. This could be used to identify those engaged in money laundering or tax evasion criminally, but it could also be used to undermine the decentralized appeal of cryptocurrencies in general.

Regulatory Enforcement

Because blockchain technology eases the flow of assets from one geographic location to another, nation-states may have a more difficult time enforcing regulations on individuals and corporations in a blockchain-based economy as opposed to an economy where businesses deal with fiat currency, the nation-state banking system, and have a physical location. Government officials are already having difficulty enforcing regulations on platform economy corporations such as Airbnb. Researchers have found that at least half of all short-term rentals in New York City in violation of New York State law (Clampet, 2013).

Policy Making and Voting

Proponents of blockchain-based voting systems say that the casting votes should be viewed as a transaction, and blockchains are very good at the accounting of transactions. They argue that with blockchain technology's public audit accounting, the public would be able to count the votes themselves to verify that no votes were changed or removed, and no illegal votes were added. FollowMyVote is one example of a blockchain-enabled secure voting system[7].

[7] For more information see the Follow My Vote 2020 Report here https://followmyvote.com/the-state-of-follow-my-vote-2020-report/

Developers claim that “Voters can follow their vote into the ballot box to independently verify that their vote was cast as intended and counted as cast” (Fillament, 2017). In Ukraine, government officials are conducting tests of blockchain-based election platforms for petitions and advisory votes at the municipal level (Abouzeid, 2016). Furthermore, candidates for office are increasingly including blockchains in their platforms. For instance, in recent London municipal elections, multiple candidates discussed the democratizing potential of blockchains (Williams-Grut, 2015), arguing alongside the Green Party’s Gulnar Hasnain that the technology offers “more decentralized power, smaller government, a need for a shift in the concentration of power in the banking system and a more inclusive society” (Perez, 2015).

There are several initiatives to use blockchain technology to secure the city, state, and national voting. A pilot voting system is underway in the Swiss city of Zug that uses blockchain technology to engage in polling and verify residents' IDs (Zhao, 2018a), Sierra Leone is piloting blockchain voting in their presidential election (del Castillo, 2018), Moscow's municipal government announced a program of blockchain-based voting (Hochstein, 2018) and West Virginia had initiated a voting pilot project for active-duty military (Zhao, 2018b).

Public Wealth

Blockchain technology could be used by nation-states to improve their benefits management programs, including Social Security, Medicare, Medicaid, Veterans Administration, and others. It could also be used to expand benefits to the public, such as the provision of a universal basic income (Fabbri, 2018).

Law and Criminal Justice

National legal and policing systems could use blockchain-based automation and collaborative working processes to reduce inefficiencies caused by paper-based and legacy technologies. A technologist in the U.K. Ministry of Justice, Alistair Davidson (2017), argues that blockchain technology could be used to create a digital record of officer-worn camera footage, "As digital evidence such as documents, emails, and video footage becomes more and more important, we need to make sure that procedures and mechanisms for verifying the integrity of this evidence are kept up to date and appropriate for a modern digital society." LegalThings (2018), a blockchain start-up in Amsterdam, is partnering with the Public Prosecution Service of the Netherlands to build a cell phone application that will quickly process low-level offenders, thereby shortening the processing time from two days to a half hour. Another blockchain start-up company, BailBloc (2018), raises money through cryptocurrency mining for the Bronx Freedom Fund that helps low-income people post bail.

Public Transportation

Blockchain technology could be used to improve and expand participation in public transportation. For example, the government of Malta is partnering with a UK blockchain startup called Omnitude to make the Maltese Public Transport Service system more reliable. Ian Borg (Independent, 2018), the Maltese Transportation Minister, said, "It will improve the quality of life and enhance access to information for Maltese citizens. Blockchain technology is a key part of our overall national technology strategy that will see us transform different sectors."

Land and Natural Resource Management

Several nation-states are adopting blockchain technology to the regulation of land titles and the administration of national resources. The Republic of Georgia, Ukraine, and Sweden are

piloting blockchain land titling projects (Reese, 2017). These blockchain-based public databases give landholders proof of the validity of their titles, which could enable them to borrow against their value (Shin, 2016). Elliot Hedman, of Bitland Global, is working on a land title registry in Ghana, "As for the benefit of a blockchain-based land registry, look to Haiti. There are still people fighting over whose land is whose. When disaster struck, all of their records were on paper, that being if they were written down at all." (Reese, 2017).

International Development

In 2018 the United States Agency for International Development (USAID) created a primer (Nelson, 2018) on blockchain technology with the goal of assessing the impact blockchain technology will have on international development. USAID is an independent agency of the United States federal government responsible for administering civilian foreign aid and development assistance. They conclude that while blockchains could facilitate the transfer of an asset or help transparently document the exchange of an asset, in actuality, most blockchain applications will rely on adjacent legal and governmental systems.

Automation and The Working Public

One of the most straightforward justifications for the government is providing for the public good. The idea of the government as the protector is predicated in part the ability of citizens to maintain stable and adequate employment. Blockchain technology's ability to automate numerous types of work will impact the ability of the nation-state to maintain cultural hegemony (Gramsci, 1992). Blockchain technology-enabled automation may alter industries engaged in asset utilization, supply chain management, quality control, service performance, and resource use. Rather than impacting any one sector, as in previous waves of technological change,

automation from blockchain technology holds the potential to replace a percentage of workers in nearly every sector of the economy (Dyer-Witheford, 2015). Fully 45 percent of work activities could be automated in the next decade (Chui et al., 2015). For example, in the service sector, Amazon has automated pick up locations (Wingfield, 2017), and there are fully autonomous taxicabs in major cities around the world, including Singapore, Dubai, and Pittsburgh, and automated long-haul trucks are not far into the future (Davies, 2015).

There is a clear corporate trend towards automation, and blockchain technology could accelerate this process as smart contracts can replace some forms of human management. Historically most jobs lost to automation have been replaced with lower-paying, repetitive, and menial labor. In a blockchain-based economy, it may prove that the highest-paid occupations in the economy, such as C-Suite officers, financial managers, professors, and physicians have a significant amount of activity automated (Chui et al., 2015). In addition to professional, highly skilled jobs, much employment in management is at risk due to automation. This is undoubtedly a threat to public-sector unions, and because unionized government employees are the last stronghold for the national union movement as a whole, their erosion threatens all workers.

Developers are creating blockchain-based applications called DAOs that would enable corporations to run via software that automates and distributes profit margins, management, and services. The corporate attorneys, accountants, and bureaucrats whose job it is to confirm the trustworthiness and legal standing of contracts between parties could find themselves replaced by blockchains (Dew, 2015).

The social costs of unemployment, including decreased health and quality of life, are borne not only by individual workers but also by their families and communities. Under cooperative

system jobs replaced by automation would lead to greater leisure time. However, under the current system of global capitalism, increases in automation will likely follow a historical path necessitating even further productivity gains or corporate entrance into larger markets to maintain the same levels of profit (Marx, 1904).

Blockchain technology could indeed be used for purposes contrary to the public good. As there are no international instrumental agencies that currently have the ability to stop the U.S. government from engaging in illegal acts of aggression such as the U.S. attack on Syria and human rights violations like separating children from their parents at the border, it seems unlikely that any new international and transnational agencies of monitoring and control of blockchain technology would be any more effective. Blockchain technology's development is still in its infancy, and there remain multiple challenges to widespread adoption by nation-state agencies, including technological hurdles, legal considerations, and risk management concerns. Blockchain technology has the potential to restructure national institutions, but it is too soon to accurately predict what these changes may be. If blockchain technology is to become a useful tool for overcoming the persistent challenges faced by the people of the world, we need to have a clear understanding of the dynamics of the problems that need to be solved and how we will react to the shifting power dynamics.

The U.S. government currently uses technology to engage in targeted voter suppression (Palast, 2000; Norris, 2014; Simon, 2016), ‘predictive policing' of communities of color (Jouvenal, 2016; Winston, 2018), restriction of food assistance money (Templeton, 2016; UK Government Chief Scientific Adviser, 2016), and the Chinese state is using technology for its ‘national reputation system’ that ranks its citizens based on their economic and social status (Chinese State Council, 2014). If we take a broad view of how nation-states have used new

technologies, it seems reasonable to conclude that blockchain technology will be used for totalitarian rather than democratizing ends.

E. Services and Supply Chains

The use of blockchains to achieve the disintermediation of service aggregators is an increasingly common feature of the service sector, particularly in the area of supply chain management. The widespread adoption of the Internet has facilitated the rise of large-scale service aggregators like Facebook, Uber, Airbnb, Amazon, and eBay. These corporations make it their practice to maximize value capture off transactions, and thus profit. But blockchains enable communities of producers to take over service aggregation themselves. Blockchains allow for the disintermediation of service aggregators by handling the search, contract, reputation, and payment systems for much less expense. This translates into greater retention of value by producers, as opposed to middlemen, something that has been a longtime goal of the cooperative movement. Used in this manner, blockchain applications democratize wealth creation, engage more people directly in economic decision-making, and thus flatten power structures. For example, Mycelia is a blockchain proof-of-ownership application for artists. Developers at Mycelia state their mission is to "empower a fair, sustainable, and vibrant music industry ecosystem involving all online music interaction services" (Mycelia, 2017). The Mycelia blockchain application attaches a smart contract and a digital wallet to each song, enabling money to flow directly to the artist. Similar blockchain applications could be used to protect all types of intellectual producer content, including academic journal articles, artwork, inventions, and movies.

Disintermediation in the area of supply chain management is of importance to cooperatives generally, and in particular, to the expansion of cooperative exchange mechanisms via the construction of a technological commonwealth. This is so for several reasons: first, because ethical production and exchange are essential norms in cooperative economics; second, because supply chain transparency performs important functions in achieving those ecological, labor, human rights, and other ethical goals. The supply chain management firm Provenance describes the problem as follows, "Opaque supply chains are devastating environments and compromising the wellbeing of people, animals, and communities. Every product and business is different, but rarely do we have the information we need to make positive choices about what to buy." (Provenance, 2016).

Developers at Provenance are using blockchain technology to document the authenticity and origin of materials and ingredients in consumer products, arguing that their application "can disrupt how we track the attributes and journey of every material thing – powering a system everyone in the supply chain can be part of" (Provenance, 2016). Similarly, developers at Skuchain are building a system of material identifiers in the structure of both barcodes and RFID tags to digitally enable the transfer of goods across the entire global economy (Skuchain, 2016). Producers that engage in socially responsible and beneficial environmental and labor economic practices may gain data that allows them to determine the extent to which they are indeed investing in people and the planet. Correspondingly, consumers may gain information that allows them to evaluate the legitimacy of claims and pricing of ethical products (Skuchain, 2016). However, the quality of the data being reported will likely need to be verified with truly independent social audits.

Increased producer control of distribution, exchange, and therefore supply chains is fundamental to the construction of any commonwealth. In the late nineteenth and early twentieth centuries, cooperatively managed storage, transportation, and wire services allowed for the construction of commonwealths across the North American plains and Great Lakes regions in Spain, Palestine, and other regions. In the twenty-first century, blockchain technologies are being used to democratize service aggregation and to manage and reveal supply chains on a global scale.

F. Commons-Based Peer Production

There has emerged a new model of value creation, which Yochai Benkler (2016) has called 'commons-based peer production' (CBPP), and whether it offers new solutions for integrating externalities in our economic systems. CBPP is open, collaborative ecosystems that allow for a fluid flow of contributions towards the joint construction of common goods, i.e., the commons. CBPP ecosystems are a modern manifestation of the desire to organize production around the commons. The commons are shared resources that are maintained or produced by a community or a group of stakeholders, governed according to the rules and norms of that community.

The first modern iteration of the CBPP model was the production of digital goods, or the joint production of knowledge, software, and designs that are commonly accessible via digital networks. Of course, the production of such goods requires material infrastructures and human bodies, but the output is considered non-rival or even anti-rival[8] (Weber, 2004) because it can be reproduced digitally. This means that the resulting production either does not lose value by

[8] Steven Weber argues free software is more than anti-rival, because it benefits from network effects: more use, even 'use for free', is beneficial.

being shared or that it actually gains value the more it is used. After the initial extraction of value from nature and human labor, the non-rival product's duplication requires very little additional input. Importantly, these digital resources have value among a community of users whether or not they have 'market' or exchange value. These digital goods' value is in the first place their 'use-value,' but since these resources are abundant, they do not fit well as the direct creation of market value, which requires scarcity, a tension between supply and demand. However, they can be a commons for a commercial sector and thus generate markets that use them, surround them, and create added value through them. What is innovative is that in peer production, the primary motivation is the creation of use-value.

For example, a report from 2011, Fair Use in the U.S. Economy (CCIA, 2011), calculated the value for the US economy of activities centered around such shared resources to be one-sixth of GDP. These figures reflect the situation before the growth of another form of - often by private platforms - mutualization in the form of shared services, the so-called 'sharing economy.' The concept of sharing does not here denote sharing as classically understood, but rather idle-sourcing, defined as the capacity to put resources such as housing and transportation into a common usage pool. These resources may have previously laid dormant or were difficult to bring to the market before the ease of use of digital networks. In this latter form, while the platforms are generally intended to create market exchange between peers directly, there are no commons nor really shared resources. However, there is an emergent part of the sharing economy that practices 'platform cooperativism' (Scholz, 2016). In this model, it is the platform itself that is the shared resource, as it may be commonly held by an association, a cooperative, a group of users, or collectively managed by a group of stakeholders. In this context, it is the

ecosystem that functions as the common infrastructure for a particular market that functions as a commons, because it is not privately owned or managed.

Cosmo-local production is sometimes summarized by the statement *everything that is light is global and shared; everything that is heavy is local*. The P2P Foundation definition of cosmo-local production includes three components:

1) A cosmo-local project is based on globally shared processes, protocols, software, designs that must be available beyond a single corporate entity.

2) A cosmo-local project is based on the "subsidiarity of material production," i.e., the production must be as close as sensible to the place of human need; this is therefore not the localization of everything, but a sensible reorganization of supply chains toward more local (in diverse senses, such as bioregional); the model is most commonly associated with the idea of a network of micro-manufacturing entities or distributed manufacturing.

3) Cosmo-local production implies generative market or non-market entities, which can come in a variety of acceptable formats, such as cooperatives, purpose-driven companies (B-Corporations), solidarity, and social economy.

1. Holochain

With Holochain, I found this missing piece, the bridge between the old paradigm and the new. We need a way to set collective goals and guide the actions of individuals towards those goals with clear feedback—this could take the form of incentive and discouragement. What we need is a global nervous system of humanity as a whole—a system that guides and combines individual actions towards a greater outcome and

one that separate individuals could not achieve on their own. (Holochain Community Matters, 2019, Raphi, A systems Thinker and Holochain Community Builder Located in the Crypto Valley, Switzerland)

Different from blockchain technology, Holochain technology is also a powerful decentering tool and a new way of running genuinely peer-to-peer applications. In the past, to serve content, a computer was required to store the content. If the content was not currently available on that machine, there would be no way to share it with someone else. In the current moment, data is stored in the cloud in large central server farms owned by companies like Amazon and Google. Holochain gives computers the capacity to access content from peer-to-peer applications right when it is needed, enabling just-in-time content delivery.

The founders of the MetaCurrency Project, Arthur Brock, and Matthew Schutte are both familiar with the P2P Foundation. Their team is engaged in what they term ‘deep wealth design,' which means being able to measure, appreciate, and make tangible value while maintaining the integrity of the system. They oppose capitalism because it measures everything regarding traceability or how much value can be extracted, and their team is designing cryptocurrencies to make deep value visible[9].

Their guiding principles are the application of biomimicry to crypto-technology to encourage principles of living ecology through inspiration from natural systems. They are also seeking to build technologies that are agent-centric and not data-centric so that the users are in control. The user is placed in charge of their data and is solely responsible for offering permission for others to access it. Thus, the role of technology is to connect each user to a more extensive system and

[9] For more information see https://medium.com/metacurrency-project/the-new-currency-landscape-9964b2c96495

to balance the control of each user's identity with their reputation even as they interact with other users.

The goal of the Metacurrency project is to build an ecosystem capable of interoperable currencies instead of one global, anonymous digital cash blockchain (MetaCurrency, 2018). MetaCurrency members want to give communities of all sizes the technological tools that will enable them to manage their resources more effectively through mutual credit systems (Harris-Braun, 2018). In this type of mutual credit system, all accounts start with a zero balance. A participant extends credit to another user in a standard spending transaction, and only with the extension of credit are units of currency issued[10]. For example, with the first transaction takes place between Hannah and Joseph, where Hannah pays Joseph 20 credits for a loaf of bread, Joseph's account will be +20 credit, while Hannah's account is -20 credits. This form of accounting practice does not place any limit on the number of assets available in a system; all assets are balanced by an equal amount of liabilities or equity. For each negative balance in the mutual credit system, there is an equal positive balance so that at any time, there is always zero balance in the system.

In a mutual credit system, the management of the currency in supply is the management of credit limits (the limit on the amount of negative balance allowed to each), which would be determined by the community. The transaction history of each account would usually be used to calculate the credit limit, and it is typically the equivalent of what could be paid back within six months (or any other arbitrary period). Thus, the actual usage patterns of the community would be used to determine the expansion and contraction of the currency supply. The founders of the

[10] A reputation system to weed out bad actors is incorporated into the currency; however initial loans of credit will require trust between participants who most likely have a relationship outside of the virtual world.

MetaCurrency Project recognize the role that the internet plays in supporting global capitalism and have built chain-based technology, Holochain, to take back the internet by eliminating centralization, a decentralized web through the use of decentralized and distributed applications widely known as dApps. Holochain's technology is being applied to mutual credit cryptocurrencies, collective intelligence, peer-to-peer platforms, cooperatives, decentralized social media, and supply chain management.

Holochain could be used for widespread disintermediation of corporate platforms such as Airbnb, Lyft, and Uber. For commons-based service platforms to be capable, each of the new services requires a decentralized currency to manage and measure the system. Each service will mainly involve developing a reputation system for non-monetary currencies, timeliness, reliability, feedback, and the way to monitor ratings. For example, with Uber, there is an incentive to keep their reputation system very simple by treating all of their customers as if they were the same to the greatest extent possible. Thus, we see the five-star rating and leave a comment. However, not everyone has the same concerns and in a more cooperative ride-sharing platform, such as what might be built with a Holochain application we might see the five stars reputation indicator regarding how good the ride was in general, but you might also rate how the car smelled, how talkative the driver was, whether the car was electric or gas powered, etc. Holochain applications are designed to be micro applications of tiny modules that can be combined together to create a more personalized experience. In this world, you do not have everybody commenting on and issuing reputation scores for the same things.

With the goal of widespread adoption, these platforms can be launched on the Holochain framework with little capital and coding expertise. This is the basis for the next networked

economy without the broken assumptions and patterns in the currency, which has become part of the structural problems.

Working to bridge Holochain technology to the current internet architecture, developers created Holo, which is a marketplace for peer-to-peer application hosting. Currently, application hosting occurs in massive data centers owned mainly by Amazon in Oregon and other states (Molla, 2018). Inside these data centers are servers. Application developers that want their apps served to visitors turn to giant companies like Amazon and their massive data centers to do this job. These data centers are using standard hardware to serve that content. Holo was designed to eliminate the need for these massive data centers by utilizing the idle and powerful computing capacity on our laptops and desktops. Globally, the amount of idle computing power dwarfs that of Amazon and the other web hosting giants. With Holo technology, when a computer hosts an application, instead of paying Amazon, the developer pays the computer's owner in Holofuel (Brock, Atkinson, & Friedman, 2018). Amazon is the third most valuable company in the world and AWS; its app hosting division makes up about 10% of its revenue, more profit than the entire rest of the company combined. To quote Arthur Brock (2019), Holochain lead developer, "Holo is aiming to do to the cash cow of the third most valuable company on earth, what Uber did to taxis. Except that with Holo, 99% of the money goes directly to the people whose computers are doing the work." (Interview with Arthur Brock, 2019)

Holo fuel is a mutual credit system of double-entry accounting where different parties have account balances associated with the hardware of a HoloPort (Appendix 4). So, if individual A transfers money to individual B, their account balance goes down, and B's account balance goes

up. Holochain cryptographically enables the distribution of value securely and globally[11]. It also enables exceptionally low-value transactions (Brock, Atkinson, and Friedman, 2018). The Visa network authenticates 56,000 transactions per second; the Ethereum blockchain can handle 20 transactions per second, the Bitcoin blockchain is below ten and falling. Transactions per second, however, are only relevant to these systems because they are doing sequential processing of transactions. Holo fuel is an innovation because it engages in parallel processing; thus, Holofuel can simultaneously handle millions of transactions per second.

Correspondingly, transaction fees are meager with Holo fuel. Again, the transaction fee for Visa is approximately two percent plus ten cents (Dwyer, 2018). For Bitcoin, the transaction fee is about $1.35 per transaction, and for Ethereum, it is something like eleven cents per transaction. However, many internet of things (IoT) and machine-to-machine transactions are extremely low cost. So, if one needs to spend even five cents to pay someone a penny, it does not make economic sense. Holo fuel is efficient enough for microtransactions worth less than a cent. The Holofuel fee is always 1% or less, so a transaction of one penny carries a fee of 1/100 of a penny (Brock, Atkinson, & Friedman, 2018).

III. Blockchain Futures

A. Countervailing Tendencies

Bourdieu (1990) said that imaginaries exist in between the mental and the material and in between individual free will and group habitus. Current institutions, practices of governance, regulatory systems, and patterns already embody sociotechnical imaginaries that resist change.

[11] Credit limits are directly connected to a demonstrated capacity to repay a negative balance by providing hosting resources. HoloFuel is directly redeemable for hosting services. (See more at https://holo.host/faq/)

These occurrences and processes of resistance offer insights into existing underlying dynamics of power and assumptions about what is right. Resistance is most easily discernible in the early stages of development of new technologies, "when evolving regulatory systems are grappling with alternative framings of risks and benefits" (Jasanoff & Kim, 2015, p. 329).

Gathering in physical settings such as the Blockchain Summit (Vavilov, 2016) and in online communities such as Fair.coop, a growing movement is using blockchain technology to lay the foundations for a technological commonwealth. Yet cooperatives and the cooperative movement are not the only social forces involved in blockchain deployment. Depending on the applications and conditions under which they are introduced, blockchain technologies may have contradictory effects, strengthening hierarchies, centralizing power, and exacerbating inequality. It is too early in the history of the blockchain world to reasonably evaluate and reach conclusions about every significant contingency, but we can and should at least begin the research process by identifying emergent and sometimes contradictory tendencies, recognizing that existing social relations influence technology deployment. The digital world and social world shape and condition each other (Latham & Sassen, 2005; Sassen, 2007).

Despite the general characterization of blockchain technologies as tending toward decentralization, incumbent and new industries are emerging that are using blockchain technology to reinforce established positions. Venture capitalists, global accounting firms, big banks, and traditional state actors are already engaging in some blockchain practices that tend toward exclusivity, stratification, deregulation, and corporate sovereignty. One example of these practices is the development of private blockchains that only publish limited amounts of data to specific users in financial services (Rizzo, 2016). This kind of implementation is described by decentralist blockchain innovators such as Eugene Lopin, CEO of CHEX, "as a counter-

productive grab to maintain centralized control" (O'Connell, 2016). Other such examples include the rush to secure exclusive blockchain patents on open-source code (Kharif, 2016), banks that lobby governments to restrict FinTech competition (Arnold, 2017), and expanded state control over how social welfare recipients use public aid (Cellan-Jones, 2016). Thus, blockchain technologies are already being used in ways that tend against the kind of democratic governance and ownership essential to the construction of a technological commonwealth. Specifically, some blockchain applications tend toward the widening of the technological divide, an increase in automation and stratification, new forms of deregulation, and the emergence of corporate sovereignty.

Latour (1987) argued that scientific ideas become standard when they are adopted and circulated by centers of power. In contrast to Latours' notion of symmetrical circulation, sociotechnical imaginaries coproduce technological systems on a global level (Jasanoff, 2014). Part of the goal of this research project is to identify the translation agents who are transporting imaginaries from one sociopolitical setting to another.

1. Digital Divide

A very advanced level of technical expertise is required to build blockchains. This puts the creation of blockchain applications outside the ability of the average user and centralizes the power to decide what type of blockchain applications developers create. It has been said by Steve Jobs as well as others that to facilitate user adoption, technology should either be invisible or beautiful. Current blockchain technology is neither, but the creation of user-friendly interfaces will develop, and blockchain applications will likely be widely adopted within the next ten years (Tapscott & Tapscott, 2016). As has occurred in prior technological revolutions, blockchain

applications may differentially reward the technologically adept, in this case, those most skilled in coding, contracts, finance, and online applications. These *Technorati* - those who are most skilled in the uses of high technology (Wiktionary) - may use blockchains to enrich and empower themselves or to limit the freedom of action of subaltern groups.

We are seeing an emergence of a blockchain technological elite, in whom blockchain users must place their trust. Facilitating such trust will require the creation of mechanisms of regulation, ensuring blockchains' legality, code security, and probity. While blockchains themselves hold the potential to be un-hackable, the applications built around them may contain vulnerabilities. Codes are subject to error, and a flaw in the code of the Ethereum-based contract system allowed a hacker to steal approximately $50 million (Maras, 2016a). Individuals who lack the necessary expertise to assess the level of security surrounding a blockchain application will be more vulnerable to financial loss. Perhaps this is one reason why several elite business schools have begun to integrate blockchain studies into their curricula (Murry, 2016).

Blockchains require specialized knowledge for their creation. An additional level of expertise is required to include smart contracts within the database's functionality. As is currently the case in the field of law and contracts, those most familiar with legal processes and institutions often prove more easily able to navigate the political and financial universe (Galanter, 1974; Rosenberg, 2008). The smart contracts coded by developers are supposed to accurately reflect the negotiated terms between two (or more) parties, but the parties will need a way to verify that the smart contract is error-free. Such disparities of the law in action may become more salient as the permanent and immutable nature of data on the blockchain could make the severing of contracts increasingly difficult. New statutes, rules, and procedures will need to be developed to address issues of equity in smart contracts. For instance, smart

contracts could be tested on a simulator to see how they perform in response to unexpected and expected messages from users and other contracts (Mlynar & Schaefer, 2016).

2. Automation and Stratification

Historically, most jobs lost to automation have been replaced with lower-paying, repetitive, and menial labor (Autor and Dorn, 2013). Blockchain technology is helping to make existing systems more efficient, and Ethereum smart contract technology allows developers to build applications to create businesses that run themselves with distributed and decentralized profit margins, management, and services. These independent decentralized autonomous organizations (DAOs) or decentralized autonomous corporations (DACs), built with blockchain technology, eliminate the lawyers, accountants, and bureaucrats whose job it is to confirm the trustworthiness and legal standing of contracts between parties (Dew, 2015). The widespread replacement of traditional corporate organizational forms with DAOs will almost certainly mean significant layoffs. A DAO could function to automatically leverage multiple smart contracts with multiple stakeholders. An example is Colony, which is testing a decentralized platform for work collaboration (Colony, 2017). And while the collaboration enabled by DAOs could benefit the cooperative movement, automation will very likely cost many people their jobs. The Economic Report of the President (2016) suggests that blockchain and other technology will eliminate jobs paying below $20 per hour and reduce by one-third those in the $20 to $40 range.

The company Slock.it uses smart contracts, distributed ledgers, and the Internet of Things (IoT) to automate a smart lock system which facilitates the automatic renting of assets (Slock.it, 2017). Slock.it's founders argue that their technology is necessary for "producers to address

decentralization or risk being disintermediated" (Tual, 2017). The lending and insurance agreements are processed by a DAO on the Ethereum blockchain. Additionally, the largest private employer in the United States, Walmart, plans to use the Hyperledger blockchain platform developed by IBM to manage its pork supply chain in China (Hyperledger, 2017). This blockchain technology will automate the recording of food storage temperatures, expiration dates, farm origination details, batch numbers, and more (Redman, 2016). In these examples, self-executing smart contracts will potentially dramatically decrease the cost of management, enforcing contracts, or making payments, which could mean millions of employees would lose their jobs. The social costs of unemployment, including decreased health and quality of life, are borne not only by individual workers but also by their families and communities (Liem & Rayman, 1982). Jobs made redundant by blockchain technology will likely be replaced with virtual labor created to automate knowledge-based tasks (Rifkin, 2014). Under a cooperative system, jobs replaced by automation would lead to greater leisure time (Gourevitch, 2014). However, under the current system of global capitalism, increases in automation would then follow the historical path of necessitating even further productivity gains or corporate entrance into larger markets to maintain the same levels of profit (Marx, 1904). Neither capitalist scenario would lead to an improvement in people's lives. Notably, both productivity gains and market expansion are becoming increasingly difficult to access under contemporary global capitalism, suggesting that systemic change of the kind sought by the cooperative movement may be necessary (Moore, 2015).

3. Regulation/Deregulation

The movement of assets involved in blockchain transactions could allow individuals and corporations to evade state regulations as well as non-state social review processes such as eco-

certification. Major corporations and other entities involved in finance and information technologies - including IBM, Wells Fargo, London Stock Exchange Group plc, the European Central Bank, Accenture, Cisco, NASDAQ, Fujitsu, Intel, and Mitsubishi—have invested heavily in developing new blockchain applications (Maras, 2016b). As these entities, as well as future DAOs, channel ever more economic activity through unregulated and/or private blockchains, public oversight may become increasingly difficult. In contrast, businesses that have a physical location, a readily identifiable CEO, and a board of directors are currently more accessible to regulation than decentralized peer-to-peer networks. For instance, distributed economy platforms such as Airbnb pose enforcement challenges, with at least half of all short-term rentals in New York City in violation of New York State law (Clampet, 2013). Thus, policymakers face new challenges in designing regulatory frameworks that are capable of dealing with the constantly changing, dislocated, and highly mobile economic actors of the twenty-first century. This is doubly true of non-state cooperatives and companies concerned with supply chain transparency, ethical production, and democratic management. At the same time that cooperatives deploy blockchains to increase regulatory accountability, blockchain applications by major corporations may, in the future, redirect value flows away from regulatory oversight (Buntinx, 2016b).

B. Environment

So how will blockchain technology impact the global environment? Blockchain technology's ability to handle contract administration and management (Box 1) is being used by agriculture cooperatives such as *AgriLedger* (Hammerich, 2018) and by energy cooperatives like the *Pylon Network* (Klenergy, 2017). But, before we explore the promising environmental applications of blockchain technology, it is important to note that the initial design of the first blockchain is

proving to have high environmental costs. The maintenance of the Bitcoin blockchain consumes more energy per year than several countries (70 TWh)(Box 2, Digiconomist, 2018), equaling approximately 20 megatonnes of CO2 emissions or about 1 million transatlantic flights per year.

Box 2. Bitcoin Energy Consumption Key Network Statistics

Description	Value
Bitcoin's current estimated annual electricity consumption* (TWh)	70.39
Annualized global mining revenues	$6,047,411,765
Annualized estimated global mining costs	$3,519,699,184
Current cost percentage	58.20%
Country closest to Bitcoin in terms of electricity consumption	Chile
Estimated electricity used over the previous day (KWh)	192,860,229
Implied Watts per GH/s	0.185
Total Network Hashrate in PH/s (1,000,000 GH/s)	43,393.00
Electricity consumed per transaction (KWh)	1,033
Number of U.S. households that could be powered by Bitcoin	6,517,961
Number of U.S. households powered for 1 day by the electricity consumed for a single transaction	34.93
Bitcoin's electricity consumption as a percentage of the world's electricity consumption	0.31%
Annual carbon footprint (kt of CO2)	34,493
Carbon footprint per transaction (kg of CO2)	506.4

(Digiconomist. (2018). *Bitcoin Energy Consumption Index*.)

In addition to the use of energy, mostly fossil fuels, for Bitcoin transaction decryption and verification, we must consider the planetary and labor costs of creating millions of computer graphics cards that become obsolete every time the blockchain grows more massive than the card's processing power; roughly every 1.5 years. Mining/maintenance of Bitcoin remains profitable even at the current low price of $7,600, and if the price of bitcoin were to increase to $50,000, the electricity consumed by mining firms validating Bitcoin transactions would increase

tenfold. Also, all the electricity currently generated in the world could still be profitably consumed at a bitcoin price of $1.1 million[12] (Hern, 2018).

As discussed earlier, blockchain maintenance does not, in every case, require massive consumption of electricity and specific maintenance models over others reify different economic logic. And, if technologists can design out the environmentally destructive consequences of blockchain maintenance, then there are many promising environmental applications of blockchains. Blockchain technology's unique combination of material tendencies could be used to help the environment. The following are areas that may be disrupted by blockchains: environmental treaties, non-profits/NGOs, carbon tax policy, individual lifestyle, energy efficiency, recycling, and supply chain management.

Blockchains could enable the tracking in real time of material extraction, compliance of environmental treaty obligations, resilient supply chains and streamlined supplier onboarding. As a shared version of the truth, they offer permissioned users' greater visibility within supply chains. Blockchain enabled smart contracts can automatically engage new (blockchain verified) vendors to prevent supply chain disruptions when certain conditions are met. Blockchain-enabled applications could also track and prevent the spread of diseases or food poisoning. For example, there is a pilot project under development by the *World Wildlife Fund, ConsenSys, TraSeable,* and *Sea Quest Fiji Ltd*, which is using blockchain technology to track Pacific tuna from 'bait-to-plate.' Further blockchain applications are under development to protect other threatened and endangered species such as the Giant Panda, Sea Otter, Asian Elephant, Indian Tiger, Blue Whale, and others (Patki, 2018). Endangered trees may also benefit from blockchain technology

[12] For more information see https://digiconomist.net/bitcoin-energy-consumption

as the Program for the Endorsement of Forestry Certification is investigating blockchain as a sustainable forestry solution (Dabbs, 2017).

Non-profits/NGOs would be able to use blockchains to automate much of the administration and management of donations. By using blockchains to track where donations flow, these organizations would be able to reduce bureaucratic costs. Many of the world's unbanked, those without access to traditional bank accounts, would be able to use blockchain applications to transfer money without having to go through intermediaries or government bureaucracies and their associated fees. *Bitgive* and *Bithope* are two non-profit charities that are working in countries that lack banking infrastructure. Blockchain enables the real-time tracking of funds on the *Bitgive* network (Bitgive, 2018).

One of the challenges to comprehensive carbon tax policies is the problem of transparency and tracking corporate polluting behavior. Blockchains would be able to automatically calculate the tax on products based on their carbon footprint. This technology would also make more transparent each company's reputation for emissions pollution. For example, a Swiss non-profit called *Poseidon* has developed a new 'carbon currency' system using the blockchain platform *Stellar.org*. This system is primarily targeted at individuals who want to keep track of the carbon value of everyday products. The *Poseidon* platform uses smart contracts and cryptocurrency to automate a carbon tax trading system (Poseidon, 2018).

Blockchain technology would also transform the energy sector. Blockchains enable peer-to-peer electrical grids. These platforms would use smart contracts to automate the cooperative management of community electricity. These cooperative platforms would improve energy access to those in poverty or create resilience in areas prone to natural disasters. For example,

ConsenSys and LO3 Energy built the *Transactive Grid*, a blockchain platform that timestamps each energy transaction and collectively manages energy through a community network (LO3Energy, 2018). *SunContract* is another blockchain-based peer-to-peer energy trading platform for solar and other renewables (SunContract, 2018) and *ElectriCChain*, which aims to incentivize solar installations around the world with a *SolarCoin* (ElectriCChain, 2018).

Biologist Guillaume Chapron said, "One reason why we have environmental crises, like the overexploitation of natural resources, and pollution, is because the global economy is full of actors who are doing business without much accountability" (Stockton, 2017). Recycling could be transformed through the use of blockchain technology. Blockchain technology's transparent tracking mechanism would encourage recycling behavior by both individuals and corporations by rewarding desired activity (such as returning used bottles) with tokens that are redeemable for fiat currency. Moreover, blockchains could also improve the efficiency of recycling programs. For example, *Social Plastic* (aka *Plastic Bank*) and *RecycleToCoin* are two projects that could improve recycling. *Social Plastic* is setting up a currency system based on plastic (SocialPlastic, 2018). When people in 'third world countries' turn in plastic to a *Social Plastic* collection site, they will be rewarded with something of value such as cryptocurrency, cell phone charging time, or cooking fuel. Also, in development, *RecycleToCoin* is a blockchain-powered dApp designed to accomplish a similar goal of automating incentivized plastic recycling (BCDC, 2018a).

Many individuals profess a strong desire to live a more environmentally friendly lifestyle but are unsure as to which products to buy due to a lack of easily accessible information regarding each company's and product's environmental impact. The current eco-certification system suffers from many flaws. The primary consumer complaint with the ecolabel system is that there is just too much information. Currently, there are 463 ecolabels in 199 countries and 25 industry sectors

(EcoLabel Index, 2018). Blockchain applications are under development to shorten supply chains, reduce carbon footprints, reduce slave labor, and make products more environmentally friendly.

Blockchain technology would make sustainable corporate practices more visible by allowing each company the opportunity to tell the world about their environmental practices. Blockchains would make transparent those aspects of the economy that are currently opaque. Producers and consumers would track products from their origin to the store shelf. For example, the supply chain management firm *Provenance* wrote, "Opaque supply chains are devastating environments and compromising the well-being of people, animals, and communities. Every product and business is different, but rarely do we have the information we need to make positive choices about what to buy." (Provenance, 2016).

Provenance is using blockchain technology to "disrupt how we track the attributes and journey of every material thing" and document the authenticity and origin of materials and ingredients in consumer products (2016). Another company, *Skuchain*, is creating a system of material identifiers in the structure of both barcodes and RFID tags to digitally enable the transfer of goods across the entire global economy (Skuchain, 2016). *FoodTrax* is a blockchain-powered dApp that plans to track food from its origin to the store shelf with the goal of eliminating food waste that occurs from improper handling and storage (FoodTrax, 2017).

These blockchain-enabled companies are attempting to offer producers and consumers information, allowing them to evaluate the legitimacy of claims and pricing of ethical products. Another environmental use of blockchain technology is its application to the bank of codes repositories. There is now an *Amazon Bank of Codes* as part of the *Earth Bank of Codes,*

> *"The … Amazon Bank of Codes … will provide an open, global public good and digital platform that registers and maps the genetic sequences of Amazonian biodiversity. By registering biological and biomimetic IP assets on the blockchain, this code bank will record the provenance, rights, and obligations associated with nature's assets to track their provenance and use. When a value is created by accessing these assets, smart contracts will facilitate the fair sharing of benefits to the custodians of nature and for its protection.* (Earth Bank of Codes, 2018).

Of course, just because blockchain technology could offer improvements in the management of environmental treaties, non-profits/NGOs, carbon tax policy, individual lifestyle, energy efficiency, recycling and supply chain management, does not mean that it will because we still live in a global capitalist system that places profit and private ownership ahead of human and other animal life.

There are several problems associated with blockchain technology in addition to the previously mentioned chain maintenance/mining costs. First, it is easy to lose one's private keys, which give access to any funds or contracts stored on a blockchain. This has led to the creation of several private firms that will store private keys as a service, however, while blockchains themselves may not be hackable, key storage service providers are, and there are many examples of funds being stolen in this manner (Zero404Cool, 2017). Another problem is the potential for corruption of information at the site of entry. Corrupt governments could use blockchain technology to record, for instance, false land ownership, and the permanent nature of blockchain ledgers could make indigenous claims even more difficult to prove.

Additionally, there have been numerous attempts in the last 20 years to use digital technologies to make supply chains more transparent. I am one of those people who created a company, *PosiPair.com*, to accomplish the goal of 'greening' global supply chains by allowing corporations to make public their business partners. *PosiPair* did not succeed in large part because even progressive corporations are mainly unwilling to reveal supply chain trade secrets to competitors. These corporations prefer eco-labels that do not require the revelation of supply chain secrets. It is very likely that those who are trying to apply blockchain technology to the problem of opaque global supply chains will encounter similar resistance. Finally, there is incredible volatility in the value of cryptocurrencies. Many of these blockchain-based environmental platforms are seeking to incentivize desired behavior with cryptocurrency. However, if individuals cannot count on the value they have accumulated to remain stable, they will be less likely to participate in environmentally friendly activities.

C. Sovereignty

> *How strange, then, that one does not find much democracy at all in synthetic worlds. Not a trace, in fact. Not a hint of a shadow of a trace. It's not there. The typical governance model in synthetic worlds consists of isolated moments of oppressive tyranny embedded in widespread anarchy.* (Castronova, 2008, p. 207)

Among technologists, sovereignty is sometimes used as a synonym for autonomy. Yet as blockchain inventor Satoshi Nakomoto recognized, while cryptography could enable "a new territory of freedom for a few years", there is more to the exercise of political power than freedom from rulemaking (Champagne, 2014, p. 45).

The word ‘sovereign’ originally meant ‘reigns’ from ‘above.’ To be sovereign was to wield ‘supreme, irresistible, absolute, uncontrolled authority’ (Blackstone, 1976; Lubert, 2010) and to be free of responsibility for one’s acts (Bodin, 1962; Derrida, 2011). The word came into wider use in the course of the democratic and republican revolutions of the eighteenth century. These claimed to supplant the divine right of the monarch to rule with the popular sovereignty principle of ‘Vox Populi, Vox Dei’ displayed on the banners of the American Sons of Liberty, among many others (Young, 2006) and were substantially built out of the religious disciplinary practices of common people (Gorski, 2003). As part of that revolutionary process, the concept of sovereignty functioned to legitimate a particular form of territorial rule and to discourage challenges to that rule (Morris, 2000). It thereby became available as a historical force establishing, among other things, a basis for claims of national sovereignty.

Whether sovereignty has always functioned in a very similar way is debated, and alternative descriptions of sovereign power have been introduced to describe the functioning of a global system (Arrighi et al., 1989; Robinson, 2014), empire (Hardt & Negri, 2001; Adams & Steinmetz, 2015), societal institutions (Sciulli, 1992, Teubner, 2012), discursive fields (Steinmetz, 2016; Blokker, 2017) and domination and daily life (Agamben, 1998; Steinberg, 2016); yet sovereignty’s continued relevance seems obvious. Sovereignty appears in contemporary discourse in alternative forms as an idealized legal concept with legitimating effect, or an emergent quality of structural power, or as a terrain of struggle raised up by challenging claims. Sovereignty is the receiving of a general recognition of exclusive domain and consequent possession of the capacity to establish the rules of conduct within a particular field of action.

Blockchain is an emergent technology that various scholars have argued is materially transformative (Manski, 2017; Tapscott & Tapscott, 2016). Its design is intended to enable the transfer of value with increased transparency, efficiency, and security (Nakamoto, 2008a). Technologies, in general, have tendencies that are materially inherent and not simply produced by social context. This is because technology is itself a structured set of relations that enables or constrains different sets of possibilities. Thus, while it may be true that the process of uncovering a technology's material components becomes increasingly challenging as one moves to the digital realm (Leonardi et al., 2013), so too does it become easier to discover the intentionality behind digital materiality: the intended tendencies of blockchain technology are directly available in blockchain code. Seven such tendencies are identified in Box 1. Where does the blockchain revolution take us? How will the advent of blockchain alter who/what is generally recognized as possessing exclusive domain, and how will it alter the capacity to establish rules of conduct.

1. Individual

The technical politics of the Bitcoin blockchain are often described as libertarian in part because the design choices of this first blockchain emphasize the technology's tendencies toward liquidity and decentralization. The builders of blockchain technology emerged from the self-identified cypherpunk movement of cryptologists and coders; Satoshi Nakamoto was a member. As Nakamoto wrote in an email to early collaborator Hal Finney, 'It's very attractive to the libertarian viewpoint if we can explain it properly' (Nakamoto, 2008b).

Back when Satoshi had first launched the software, his writings were drily focused on the technical specifications of the programming. But after the first few weeks, Satoshi began

emphasizing the broader ideological motivations for the software to help win over a broader audience. (Popper, 2015, p. 30)

Those economic libertarians who identify as ‘Ancap’ (or ‘anarcho-capitalist’) claim society best facilitates individual will in a free-market economy free from regulation by states or large corporations. The discourse of Bitcoin enthusiasts is revealing: the use of the term ‘mining’ to describe blockchain maintenance and ‘coin’ to describe a chain of digital signatures speaks to their fondness for gold.

At the same time, libertarians generally share faith in progressive technological determinism, believing that society can be improved and that social relationships and institutions can function more effectively through the use of new technological tools. Blockchain forms, such as Bitcoin, institutionalize this ideal by enabling a form of trustless direct exchange among individual property owners. Applications such as uPort ID seek to wrest control of personal data from major corporations and governments, as well as to provide privacy protections to individuals (ConsenSys 2015). Evidence is widespread and multiplying efforts by technologists to use blockchain technology to challenge existing hierarchical institutional forms with peer-to-peer networks. It seems questionable, however, whether large numbers of people, as citizens, consumers, producers, etc., will embrace a total shift from regulatory oversight toward a disaggregated society of autonomous individuals picking and choosing between peer-to-peer legal codes of arbitration and enforcement of agreements.

2. Popular

After more than two centuries of building a world beyond capitalist logic, the cooperative movement is well-positioned to make the most of blockchain’s tendencies toward globality,

liquidity, permanence, decentralization, and future focus. Through these, blockchain is beginning to convert the long-standing vision of a popular 'cooperative commonwealth' into the actual construction of a 'global technological commonwealth' enacted through the use of advanced exchange, communication, and governance technologies (Manski, 2017). There are many current examples of applications that make the decentralized global exercise of popular sovereignty possible. Blockchain for Change has developed Fummi, an application that uses blockchain's immutability and globality to store digital identities for those lacking permanent homes (Schiller 2017). Applications that make use of blockchain's tendency toward future focus (Aitken 2017) - via the utility of stored autonomous self-reinforcing agency (SASRA) to handle contract administration and management (Box 1) - can be found in the development of AgriLedger for agricultural cooperatives (Hammerich, 2018) and of the Pylon Network for energy cooperatives (Klenergy, 2017). Decentralized commons-based currencies such as Duniter and Faircoin (Bauwens, 2018) are now in use; these have been coded to reduce inequality via the provision of a Universal Dividend (also known as Basic Income) and other features. And emerging on the horizon is a series of next-generation technology platforms designed to bypass bottlenecks and inequalities contained within current blockchain architectures; the most notable of these is Holochain (Brock & Harris-Braun, 2017).

Blockchain is a powerful tool for the cooperative movement in its quest for economic democracy because many of blockchain's tendencies toward globality, permanence, decentralization, and future focus move parallel to ongoing cooperative projects. Additionally, we see in the distributed and secure structure of blockchain a limited safeguard against suppression should capitalist states move against blockchain-based pro-democracy initiatives. Activist use of a simple virtual private network (VPN) or Proxy systems to access blockchain

applications is much less vulnerable to state attack than has proven the case for many centralized and 'above ground' social movement organizations. To the extent that the construction of a global technological commonwealth faces obstacles, these lie not in the tendencies of blockchain technology but instead in the somewhat insular path dependencies of the cooperative movement itself. We are uncertain as to whether democratizers will prove capable of creating a culture sufficiently open, user-friendly, expansionist, and politically ambitious to maximize the possibilities offered by blockchain.

a. Puerto Rico

The unincorporated territory of the United States, Puerto Rico, is an example of a commonwealth that lacks sovereignty. In 2012, in a controversial move, the government of Puerto Rico sought to attract investment from high net worth capitalists by passing a tax exemption to its Internal Revenue Code, Act 22, which allows non-residents of Puerto Rico to pay no taxes on their long-term capital gains if they are physically present in Puerto Rico 168–183 days per year. This occurred in the aftermath of the environmental disaster hurricane Maria that killed thousands, devastated local agriculture, and severely weakened already underfunded institutional infrastructure. After the hurricane, Puerto Rico was embraced by cryptocurrency capitalists who were seeking to avoid paying U.S. taxes on their cryptocurrency millions (Bowles, 2018).

The public vision presented by these cryptocurrency capitalists was a blockchain utopia for Puerto Rico. However, for many local islanders' this sudden concern for the plight of Puerto Ricans felt like greedy opportunism. In March 2018, I spoke at the Blockchain Unbound conference organized by cryptocurrency billionaire Brock Pierce. As suspected by locals, many

of the cryptocurrency attendees were only seeking to avoid U.S. taxes. However, it was not the case that attendees were all libertarians wanting to multiply their riches at the expense of the battered US colony. Many participants felt the affordances of distributed ledger technology could genuinely have a positive impact in Puerto Rico.

So, how could blockchain distributed ledger technology help the people of Puerto Rico? The university student of Puerto Rico agreed and formed EduBlock, a grassroots student network non-profit composed of professors, students, and industry-leading advisors. It began as a reaction to the influx of fintech companies and investors moving to the island but evolved into an organization with the intention of gathering as much knowledge on distributed ledger technologies as possible. Students throughout Puerto Rico have joined together to create a bridge between these new fintech companies and the local community. There are five chapters in development and three already established at top Puerto Rican universities (Mayaguez, Rio Piedras University of Puerto Rico system-wide campuses, and the Metropolitan Interamerican University) developing technology curriculum and training programs for the benefit of the people of Puerto Rico.

3. Technological

Technocracies are characterized by powerful actors and institutions able to maintain unequal positions of power through their use and control of technical knowledge. In tending toward ethereality, blockchains favor those with superior technological knowledge and positionality. Blockchain coders enjoy a comparative advantage overlay users because in calibrating blockchain over multiple prototype iterations, coders establish a lasting frame of reference through which they imagine alternatives and make design choices. This agency can be

used toward different ends, as a means of resistance to capitalism, or as a means to personal profit, or as a path to power consolidation.

Notably, the early days of blockchain coding have seen an organizational commitment to open source. Open source code is co-created in a cooperative manner and appears to be dominating the core development of blockchain. This may be true because blockchain coding is more demanding than other types of programming and because group participation in creating blockchain-based applications is inherently more purposive than individual participation in development. As blockchain applications become more lucrative, however, there are a growing cast of corporate in-house blockchain developers and blockchain developer billionaires.

At least one tendency of blockchain technology, future focus, (Box 1) may be leading toward sovereignty not of technologists but of the technology itself. The development of SASRA could enable the creation of blockchain businesses that run themselves with distributed and decentralized profits, management, and services. These independent DAOs (decentralized autonomous organizations), would automatically leverage manifold smart contracts, thereby eliminating the lawyers, accountants, and bureaucrats whose job it is to confirm the trustworthiness and legal standing of contracts between parties (Dew 2015). One example is Colony (Rea et al. 2018), which is testing a decentralized platform for work collaboration. Overall - whether in the technology or the technologists, or in service of democracy, capital, or self - there is little question, but that blockchain technology tends in every way toward some form of technological sovereignty.

4. Corporate

With their abilities to mobilize unmatched financial resources, major corporations are exploiting blockchain's tendencies toward verifiability, globality, liquidity, permanence, and

future focus to forcibly adapt the technology to their own purposes. For example, Kodak, Amazon, Facebook, and other corporations have identified the potential benefits of creating their own platform cryptocurrencies. Blockchain cryptocurrencies can include smart contracts that automatically dole out the company's currency as a reward for developers who build apps on its platform or users who engage in a desired behavior. This kind of corporate 'token economy' has the flavor of a traditional company town; in this case, the owner of the online space is the sovereign. And corporations are extraordinarily bad sovereigns (Lessig, 2006).

Indeed, already functioning corporate sovereignties such as Google claim and expand their exclusive sovereign territory by absorbing existing spaces (Bratton, 2016, p. 144). The introduction of blockchain's powers of verifiability and permanence could further the degree of data granularity captured and monetized by these corporate platforms. All of this has the immediate effect of strengthening hierarchies, centralizing power, exacerbating inequality, and generally weakening democracy. Furthermore, as some of the most advantaged players in the world system, corporations enjoy a significant head start in the race to program their logics into mainstream blockchain applications, as well as the capacity to enact state policies that block new applications threatening future disintermediation. Where the environmental economics literature describes 'technology forcing' as technological development driven by regulatory pressure, we see a similar process underway in the corporatization of blockchain toward the ends of corporate sovereignty.

5. Techno-totalitarian State

Many have claimed that blockchain technology will inevitably weaken the nation-state, and in the final analysis, it may. Yet at the moment, national and transnational state institutions are actively working to support and regulate favored types of blockchain activity and otherwise,

where blockchain applications are disfavored, ‘to regulate it out of existence’ (Nicolaci da Costa, 2018). They are going about this by criminally investigating initial coin offering (or ‘ICOs’)(De, 2018), demanding currency exchanges turn over user information (Paul, 2018), enacting capital gains taxes on cryptocurrency trades (Bernard, 2018), criminalizing non-state cryptocurrencies (Iyer & Anand, 2018), and more. At the same time, major powers such as China, Russia, Japan, and the United States, as well as regional technology leaders like Uruguay, Estonia, Slovenia, and Kenya, as well as subsidiary states, are all jockeying for comparative strategic advantage in the development and deployment of new blockchain technologies (Tapscott & Tapscott, 2016).

Such interventions signal the possibilities for states to expand their reach. In block- chain’s tendencies toward verifiability, globality, permanence, and future focus, state actors are finding greater capacities to intervene globally in the daily lives of individuals. These expanded capacities are making possible the emergence of new technological totalitarian forms of state sovereignty. States cannot easily control what they cannot measure, and a blockchain-enabled Internet of Things (IoT) amplified by artificial intelligence furthers the degree with which states can monitor the material and social world. The rapidly expanding IoT is expected to more than triple in size by 2020 to nearly 21 billion devices (Stravridis & Weinstein, 2016). When there is a tiny blockchain-connected chip embedded in each material object with which we interact, state institutions will assuredly seek to monitor and discipline the personal, political, and economic activities of the many.

This prediction should not be controversial. Political parties in power regularly use targeted voter suppression technologies to gain partisan political advantage (Palast, 2000; Norris, 2014; Simon, 2016). Police forces use technology to engage in ‘predictive policing’ that

disproportionately targets communities of color (Jouvenal, 2016; Winston, 2018). State welfare agencies use technology to track and restrict how food assistance money is spent or pension fraud or error (Templeton, 2016; UK Government Chief Scientific Adviser, 2016). The Chinese state is moving to a whole new level of state control with the creation of a national reputation system ranking individuals based on their economic and social status (Chinese State Council, 2014). Altogether, recent history gives us reason to expect that state interventions into the development of blockchain technology are more likely to lead in a totalitarian rather than democratizing direction.

D. Gender/Race

Who is building the new digital economy of distributed ledger, blockchain, and peer production technologies, and for whom are they building it? Technologies that automate governance and decision making are expanding into new areas of social life, encoding racial, gender and class biases in nearly every application, and outpacing legal, regulatory, and ethical reform. Recent research on the "New Jim Code" (race as a set of technologies generating patterns of social relations) and studies of care work show that under-recognized forms of labor are essential to the functioning of socio-technical systems (Noble, 2018; Benjamin, 2019). I apply these lessons to analyzing new enterprises intended to harness democratic participation in the governance of production.

Race, gender and class inequality are prominent in the labor of governance (the conscious work that produces governance) in emerging peer production projects using distributed ledger technologies (DLT). Peer production refers to a way of producing goods and services cooperatively via digital technology. Proponents argue that DLT-based peer production

practices enabling economic, financial, and cultural exchange largely sidestep state regulation and allow for greater social freedom (Chohan, 2017). Yet critics counter that despite such utopian goals, DLTs are subject to the same patterns of informal socialization and domination generally found within the tech community. Occasionally these dynamics in tech culture receive wide attention, for instance in the "Gamergate" scandal (Salter, 2016). Recent studies have found discrimination built into the algorithms of AI hiring, parole determination, medical care, and other technologies (Rooth, 2010; Angwin et al., 2016; Obermeyer et al., 2019).

Emergent technologies are often depicted as natural, inevitable and automatic, but critical race scholars show that tech designers and developers encode discriminatory design into technical systems reproducing racial, ethnic, class and gender inequality (Browne, 2015; Braun, 2014; Coleman, 2012; Reardon, 2004). Their research calls on science and technology studies (STS) to focus on the pernicious 'default settings' of emergent technology, particularly the values, assumptions, and desires shaping technological design. Other prominent STS scholars agree that their field must examine justice frameworks more explicitly (Fourcade and Healy, 2013; Mamo and Fishman, 2013; Shilton, 2018) and challenge our implicit assumptions about how sociotechnical work relates to organizations (Winter et al., 2014).

Who will encode justice in the organizational design of the new economy? This is a question of governance, understood as the rules, policies, and procedures structuring the operation of an organization in order to implement decisions towards shared goals. Uncritical design is likely to reproduce structural inequalities reproduced in the under-recognition of service work or 'care work' that enables organizations to function. Scholars have used a range of concepts to describe the under-acknowledged, under-rewarded, and often racialized and feminized labor in the context/processes of economic production. These include emotional and

affective labor (Weeks, 2007; Federici, 2015; Oksala, 2016), immaterial labor (Federici, 2008; Jarrett, 2014), and shadow work (Illich, 1981; Menzies, 1997). While these dynamics were noticed well before the construction of the digital economy, they appear especially relevant in the context of digital platforms that derive economic value from unpaid contributions by their users (Terranova, 2000; Jarrett, 2014), including peer production projects (Restivo and van de Rijt, 2012; Arvidsson et al., 2016).

Feminist analyses have encouraged serious attention to difference and to varying forms of inequality, rather than assuming the experiences of all women are alike or that gender equality alone will free women. Gita Sen and Caren Grown (1987) capture this understanding when they define feminism as the struggle against all forms of oppression. The technological movement sector is embedded in all the existing inequalities of the larger society, including women's oppression. As distributed ledger technology becomes more widely popular, there has been a rise in organizations building networks and platforms to elevate and promote the women's involvement and gender equality in the blockchain industry. A few examples of organizations include: Women on the Block (https://www.womenontheblock.io/), Diversity in Blockchain (https://diversityinblockchain.com/), Women in Blockchain Impact Group (https://www.wibi.io/), and Women of Crypto (https://www.facebook.com/TheWomenOfCrypto/), which are providing visibility, education and support for women in the movement and developing ways this technology can be used to help women globally participate in the economy, recover from disaster, gain leadership positions, and acquire capital investment.

These separate women's organizations exist because the current embrace of distributed ledger technology is significantly gendered. Cryptocurrency is the most widely available

application of blockchain technology, yet less than 9 percent of cryptocurrency users are female (Etoro, 2018). Following a pattern common to Silicon Valley companies generally, a study found that of the top 50 blockchain companies, just 16 percent are founded by and/or led by women (Nubchai, 2017)**.** A Swiss cryptocurrency association announced that they needed more female board members (Canellis, 2018). Most speakers and participants in DLT conferences are men, and the women who attend report feeling alienated by a hard-partying 'blockchain bro' culture (Bowles, 2018).

1. Care Work

Care work jobs provide a particular type of service that contributes to the health, wellbeing, or development of other people that require personal interaction between workers and clients (Budig and England, 2001; Duffy, 2005). The historical development of care work jobs has been bound up with changes in gender relations. The provision of care work is further complicated because it has properties of a public good. As Folbre (1994) argues, caring labor produces extensive benefits even for those who do not provide it and do not bear its costs as the whole society benefits from well-raised children or a healthy population. Because some individuals who benefit from care work can avoid paying for it, markets tend to undercompensate (and underproduce) care work (England, Budig, & Folbre, 2002). Research on care workplaces has shown popular culture shapes people's beliefs about what type of person is supposed to do a particular job and what skills they need to possess (Braverman, 1998). And, because care work is associated with women and women's skills are devalued in society, women's relational skills are attributed to natural mothering behaviors rather than job-specific behavior (England 2005; England et al., 2002), which is given as a reason woman receive less pay for their employment.

With this conceptualization of the distinctiveness of caring labor, care work scholars highlight dimensions of economic change often overlooked in other research, including the historical process through which care jobs were incorporated into the U.S. labor market, and the methods care workers have used to achieve higher labor market power. Most prior research on care work emphasizes the suppressed compensation of all care work jobs across skill, but there were also polarizing pressures that divided most care work jobs into either very low-wage labor or (semi) professional higher-wage labor as care was increasingly provided in markets. Without the 'free,' unpriced services of child-rearing, social cooperation, ethical norms, education, and natural systems, markets could not exist. Care work is different from other services in that it involves labor that was once provided mainly within families and kin networks rather than in market exchange. Care work often requires more relational and interactive skills than do other service jobs, skills that are highly associated with women, and skills that are essential for democratic governance.

Blockchain governance has become a hot topic in the popular media, but discussion of blockchain governance protocols rarely focus on the role of care work in the socio-technical imagined DLT future. Future research may find increased valuation of care work will contribute significantly to the success of DLT social movements, and that care work in governance is particularly crucial to social movement success in part by focusing on the role of gender and racial inequality in the U.S.A. Future research will likely demonstrate that the new blockchain economy is also a care economy, with particular hazards and opportunities in governance for the future of work and economic disparities in the United States.

DLT and related technologies that automate governance are rapidly expanding into, reshaping, and constructing new areas of social life. Entrepreneurs, coders, activists,

policymakers and other key actors who seek to effectively democratize and channel these technologies toward equitable outcomes need reliable analyses of inequality in the labor of governance to guide their efforts.

E. Value

The problem with the logic of capitalism is that everything, including healthy social relationships, a stable climate, having meaning in life, etc. are only considered part of the value equation when it impacts profit. Technological activists are rejecting the logic of capitalism and insisting on creating a world where humans and living systems thrive, and therefore are developing new ways to recognize value.

Valuation is a social process, and accounting is a social practice (Callon, 1998; Boltanski & Thévenot, 2006; Callon, Millo, & Muniesa, 2007; Knorr Cetina & Preda, 2012; Aspers and Dodd, 2015). Technological systems have shaped accounting in every setting, including the construction of markets, capital raising, algorithm pricing, digital platform services, and corporate organization. Some of these transformations have been the subjects of intensive study; research on others is lacking. This section addresses new digital valuation technologies that could transform values and valuations within institutions in which valuation takes place. The same technologies will allow for the reclamation of our digital identities and real reputation, which is necessary for the trust required for online organizing. Technological activists are gaining momentum in their mission to design and use digital technologies for a world beyond capitalism. In this future, people, nature, and things are not valued by the market, but rather by their capacity to further human flourishing and account for planetary limitations. These efforts are part of three contemporary historical determinants recognized by technological activists: first,

the need to evade state repression; second, the need to maximize limited resources; and third, the need to create effective institutional solutions despite past failures to do just that.

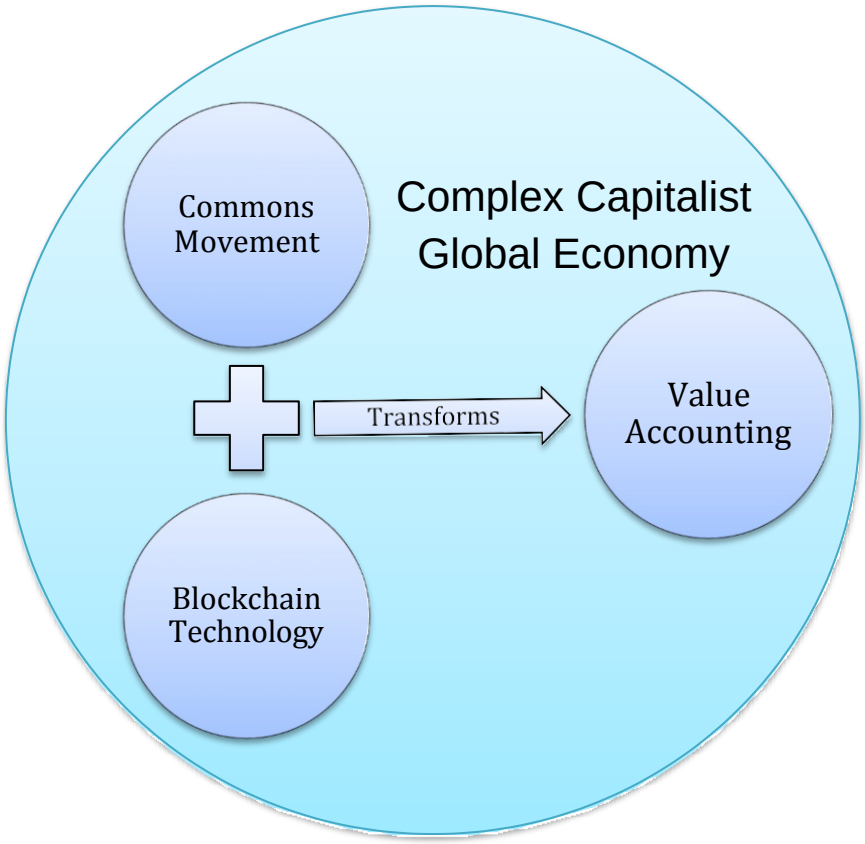
The construction of each accounting technology is mortared by ideology (Dillard, 1991). The dominant ideology of our age is capitalist. Everyday material technologies of accounting (written reports, techniques, books of accounts, pictures, charts) make possible the practice of capitalist governance and corresponding modes of social control. Accounting technologies have material agency within large socio-technical networks because they enable action at a distance (Robson, 1992), and they make 'invisible' objects visible (MacKenzie, 2009). Inscriptions of accounts enable the modern state and institutions to 'govern at a distance' and make present things, ideas and people in 'centers of calculation' (Miller, 1990; Latour, 1987),

> *... accounting cannot be independent of its social conditions. Under capitalism, the moving force of accounting lies in political economy – in class contradictions. Accounting is made, in part, by adjustment to the economic needs of the ruling class*. (Catchpowle & Cooper, 1999, p. 712)

Tinker (1985) agrees that under capitalism accounting technology is a "logic for appropriating material production," "a way of rationalizing or explaining away the appropriation of the production of one social class by members of another" as "an intellectual and pragmatic tool in social domination" (p. 100). This understanding of accounting calls on scholars interested in building a world free of economic exploitation to understand how social movements and the technologists involved are building new technologies of valuation and personal identity reflecting an emancipatory imaginary of the future beyond capitalism.

Dillard argues that a "fundamental change in the underlying economic structure must occur before change can occur in accounting technology" (1991, p. 24), but what if technological activists within social movements are able to reverse this historical process and strategically radically redesign accounting technology; imbuing new accounting technology with favorable affordances that give it transformative material agency in order to fundamentally change the economic structure? The strategic design of technology has long been a part of activist repertoires. The use of value accounting to demonstrate exploitation and inequality against capitalist opponents is commonplace and can be found among trade unionists and socialists (Gallhofer & Haslam, 2003), anti-sweatshop and fair-trade activists (Bartley & Child, 2014), anti-corporate globalization campaigners (Juris, 2007), and others. What is new in this historical moment are the emancipatory affordances of new digital systems of value accounting and digital identity enabled by distributed ledger technologies or DLTs (i.e., blockchain and holochain) (See Diagram 1).

Diagram 1. Transformation occurring within capitalism as social movements combine with new technologies.



1. Social Movements

> *If power is increasingly leveraged through online and mobile infrastructures-both on the part of movements and on the part of states-then some of the most important (and radical) movements will emerge around the use of those powerful technologies in societies.* (Ilten & McInerney, 2019, p. 210)

Blockchain technology poses both utopian and dystopian possible futures. Whether individuals, nation-states, corporations, technologists or cooperatives are empowered will depend heavily on the design choices that are made in the next few years and on the path dependencies, and political dimensions of the policies, practices, applications, and institutions created surrounding blockchain technology. Various interest groups are creating concrete practices pointing towards both the utopian and dystopian futures. While corporations and nation-states

have much more significant financial resources and institutional advantages than those using blockchain technology to build a global technological commonwealth (Manski 2017), we can look to the three most successful organizations that are using successful strategies to build a utopian future including the P2P Foundation, the MetaCurrency Project, and Fair.coop.

Before discussing these organizations in detail, it is essential to stress the role of culture and ideology in the package of successful movement strategy (Polletta, 2008). The ideology these groups share is cooperativism or moving beyond capitalism to a commons-based economic system that regenerates both people and planet. While capitalism is ubiquitous and its destructive presence is felt everywhere, the number of people involved in creating a cooperative economy beyond capitalism is not marginal. More than 1.2 billion people are members of a cooperative, equaling one in every six people on the planet. As of 2018, there are 3 million cooperatives worldwide. The 300 largest cooperatives have market capital totaling more than $2.1 trillion (World Co-operative Monitor 2017).

Cooperatives place ethics, values, and principles above profits and cooperative enterprises reinvest in individual worker-owners, communities and the growth of the cooperative movement. Rather than being paid a wage for their labor, cooperative members both own and run their businesses. This model is superior to distant corporate boards of directors running the business because the worker-owners do not choose environmentally destructive production processes or choose to close the business to move it to a lower wage location. More than 10 percent of the world's employed population, or 280 million people, enjoy these working conditions (World Co-operative Monitor, 2017).

Those millions of people who are involved in the cooperative movement are actively shaping culture, and they understand that technology can play an important role. For example, the International Cooperative Alliance (ICA) is looking at how to use technology, including blockchains, to move "the co-operative model into our digital and virtual age" (ICA, 2017). The use of blockchain technology by cooperative enterprises reveals how, "new technologies in combination with the conscious and determined exercise of political agency can create another, better world for all of the world's people" (Block, 2008).

Technologies exert agency in shaping culture. The social and material worlds engage in the process of co-construction and blockchains are being strategically built into technological institutions. A technological institution is a technology that creates sets of rules that order reproducible social practices and actions (Jepperson, 1991). Blockchains are an emergent technological institution because of their automatic and decentralizing design they consistently reordering social practices. Blockchain software is in the early stages of prescribing the entire global economy and the social practices between both individuals, organizations and other institutions. This is important when attempting to understand how movement actors are technology to build institutions to accomplish specific goals.

Actors demonstrate agency by producing and reproducing their material world, which ultimately directs the production and reproduction of the social world and the social dimensions of institutions. In this process of co-production, technologies can sometimes bring forth and reveal aspects of our culture (Heidegger & Lovitt, 1977) such as a shared goal to move beyond capitalism that was previously less visible. Technologies like blockchain can give meaning to the social world and at the same time are given meaning by the adopters of the technology.

So, what cultural and ideological components do blockchains bring forth from the ether? I believe blockchain technology reveals a sincere desire for individual freedom and a rejection of central, unaccountable, or seemingly malevolent corporate and government institutions. Through in-depth interviews, I have found that blockchain technology has acquired techno-anarchist and techno-cooperative meaning among technologists. Thousands of blockchain technologists are co-constructing their version of utopia. This co-construction of cultural meaning both opens some doors and closes others.

Pinch and Bijker (1984) discuss how the meaning of technology can be contested, especially in the early stages of a technology's development and they call this difference in meaning ‘interpretative flexibility'. In the case of blockchain technology, the meaning and appropriate use of blockchain technology is contested between highly ideological techno-anarchist/techno-cooperativist cryptocurrency traders and dApp developers, and global capitalist fintech giants and leaders of nation-state institutions. Governments, in particular, are attempting to understand, control and profit from blockchain technology. In the case of blockchain technology, interpretive flexibility can be found at every turn.

Bijker (1995) suggests a ‘technological frame' encompasses both technology and the social group of users. Pinch (2008) adds the ‘technological paradigm' includes this conceptual framework and a mode of practice of the user. So, what is the mode of practice for blockchain technology? Currently, the mode of practice and production is contested. As in the early days of the internet and intranets, there exist both public and private blockchains (Jayachandran, 2017). Some blockchains centralize wealth and power and those that decentralize resources. Some blockchains are designed to be used by the financial and technical elite, and others are built for widespread use. This battle over the cultural meaning of blockchains is vitally important because

as Pinch (2008) notes, “Eventually a frame may get downshifted into the machine itself and so constrain subsequent meanings and usages.” (p. 473).

This downshifting of a frame is called ‘technological closure'; when some design choices win out over other design choices. Also, the ease at which individual frames can be incorporated into existing cultural frameworks can influence their adoption. It is undoubtedly the case that organizations are attempting to use blockchain technology to move beyond capitalism and explicitly trying to use the technology to build new types of social arrangements. Explicit design choices are most potent in the early development of technology before standardization and policy formation is baked into designs that create patterns of use and expectations in users (Winner 1980). Additionally, Pinch points out that the less visible the process, the more power it contains because, “social choices appear to have vanished from technologies, or are so deeply embedded within technical structures that they become invisible to all but the technical experts, that technologies are powerful institutions” (p. 467).

2. Capitalism

Andrew Feenberg (2002) argued that activist struggle cannot by itself create democratic institutions in the technologically mediated domains of social life. However, he remained hopeful that technology could eventually deliver a technological civilization for the benefit of all. Some may argue that critical theorists focus less on the inherently transformative power of technology and more on the systemic unequal relations of power and the institutional structures that use all technology to reproduce systems of global capitalism. They may also argue that affordance theorists believe technologies play a substantial role in shaping the range of possible social outcomes in each era (Winner, 1980) and that critical and affordance theories are not

compatible. But this would be a false dichotomy, because critical theory and affordance theory are closely related. For example, original critical theorist Karl Marx, believed that technology was a primary motive factor in history (Smith & Marx, 1994).

Marx, examined in his writings the ways in which technology would be used in a capitalist system. Marx wrote that, "the social relations within which individuals produce, the social relations of production, change, are transformed, with the change and development of the material means of production, the productive forces. The relations of production in their totality constitute what are called the social relations, society, and specifically, a society at a definite state of historical development" (Marx et al., 1978, p. 207). Thus, as the relations of production change, then so too must social relations change.

Marx said that commodities only become capital when they are exchanged for living labor power. If there was not a class of people who were willing to exchange their labor power, then capital could not exist. Marx said, "It is only the domination of accumulated, past, materialized labor over direct, living labor that turns accumulated labor into capital" (Marx et al., 1978, p. 209). Here Marx must not only be referring to completed human labor, but also nature's work. Living labor multiples the exchange value of past labor. Capital can only increase itself by exchanging itself with labor power. In this way the relationship between capitalist and worker is interdependent but only the capitalist benefits with the use of new technology, because as capital grows and standards of living improve, profit and wages decrease.

Globalization of world markets has increased the competition between capitalists. This competition has required an increase in the division of labor to reduce the costs of production. To maintain profitability, capitalists must sell their commodities more cheaply and to a broader

market. The increasing use of technology and machinery to reduce the cost of production, and increasing levels of competition, force the price of commodities downward. The constant chasing of profit by capitalists has led to massive environmental destruction.

John Bellamy Foster (2000) argued Marx understood that capitalist exploitation of nature. It is clear in Marx's work on man's species-being and the relationship between humans and nature that Marx was writing about what Foster terms the 'metabolic rift', or the "irreparable rift in the interdependent process of social metabolism" (Marx, 1981, p. 949). Marx recognized that human labor and nature are combined to create technologies and commodities, and Marx wrote of the depletion of the soil, the pollution of water, and the destruction of common land due to capitalist exploitation. He writes in the *Grundrisse* (1973),

> *Capital creates the bourgeois society, and the universal appropriation of nature as well as of the social bond itself by the members of society*" and "i*n accord with this tendency, capital drives beyond national barriers and prejudices as much as beyond nature worship, as well as all traditional, confined, complacent, encrusted satisfactions of present needs, and reproductions of old ways of life. It is destructive towards all of this, and constantly revolutionizes it, tearing down all the barriers which hem in the development of the forces of production, the expansion of needs, the all-sided development of production, and the exploitation and exchange of natural and mental forces.* (Marx, 1973).

Blockchain technology is a part of the process described here by Marx. It was created to drive beyond the current economic, social, political and institutional barriers of the present technological era. Blockchain technology is interesting in that it was created for explicitly anti-

capitalist/anti-state purposes. An influential contemporary critical theorist of political economy is William Robinson (2011), and his theory of global capitalism is especially useful when examining global technologies like blockchains and their potential impact on economic, social and political institutions. He says that novel articulations of social power characterize global capitalism. Robinson argues that the North/South, core/periphery divisions traditionally invoked by World System theorists (Wallerstein, 1998; Chase-Dunn & Grimes, 1995; Amin, 1977; Arrighi, 1999; Gunder & Gills, 1993) are being superseded by the increasing interconnectedness of the world economy. Supply chains circle the globe with design, manufacturing, assembly, and shipping occurring in many different countries. Corporate boards of directors do not come from just one country anymore, they are usually drawn from multiple nationalities and are composed of the transnational capitalist class. This class of people travels the world most of the year and has homes in multiple countries. Globalization had integrated capitalism like never before and strengthened and expanded this transnational capitalist class. The transnational elite have more in common with each other than with their fellow countrymen. They use technologies that ease transnational flows of value and information. Blockchain technology is uniquely suited to the needs of the transnational capitalist class to free monetary value from nation-state restrictions. At the same time workers worldwide are seeing their wages and working conditions deteriorate due to global capitalism's race to the bottom (Hough, 2012). As a result, inequality continues to increase with the implementation of government austerity measures to pay back debts or bail out financial corporations.

Robinson also points out how corporate supply chains are transnational through global integration. Blockchain technology, especially the real-time gross settlement system (RTGS), currency exchange and remittance network *Ripple* (Martindale, 2018), is accelerating

transnational capital flows and globalized circuits of production (Groenfeldt, 2017). Robinson said the current crisis is unique because it is pushing past the ecological limits of production. Capitalist expansion is also running into limits on labor and nature.

Jason Moore (2015) argues that capitalism is running out of what he calls cheap natures: labor, food, energy, and raw materials. Understood as a way of organizing nature, capitalism has exhausted the historical relationship that produced cheap nature. In the early stages of capitalism, Moore argues, that many humans remained in the 'nature' category and were able to be super exploited. Moore (and Marx before him) argue that capitalism can only be co-produced by humans and nature and the false separation of environmental justice from social justice made with the "Green Arithmetic" of "Society + Nature" must be eliminated to form alliances across movements. Moore argues that nature is also historical. He introduces the concept of the Oikos, a relation of life-making that gives rise to multiple ecosystems that include humans.

Moore states that there is a global pool of money looking for profitable investment that is growing larger while the ability to appropriate work for free from nature, forests, oceans, climate, soils and human beings is dramatically contracting. There is a chronic problem of overaccumulation and increasing concentration of wealth. The vast majority of people under globalization are left with only the crumbs of the economic wealth to attempt to sustain bare life because transnational capital cannot find outlets to invest their vast amounts of wealth profitability. Technology is constantly being put to the task of increasing profitability.

The game of dueling technological strategy is being played out on a global scale, and already blockchain technologies are altering the economic foundations of global society, raising new possibilities both promising and problematic. Blockchain technology will materially transform

global political, economic and social institutions (Manski, 2017; Tapscott & Tapscott, 2016). Its creator, Satoshi Nakamoto (2008a), designed blockchain to enable the transfer of value with increased security, efficiency, and transparency; noting that these material tendencies would appeal to the anti-statist goals of libertarians, "It's very attractive to the libertarian viewpoint if we can explain it properly" (Nakamoto, 2008b).

The democratization of finance requires a corresponding redefining of value. This section briefly reviews the literature on how value is currently accounted for under capitalism, including a discussion on the tendency in capitalism toward increasing complexity. As many researchers have observed, accounting is not neutral nor separate from prevailing economic ideology (Catchpowle & Smyth, 2016; Knights & Collinson, 1987). Critical to capitalism, new accounting and production technologies and organizational forms are invented to increase productivity, reduce the costs of production and manage the resulting processes and complexities (Cooper, 2015)(See Table 3), "The only characteristics of concern are those associated with changes in the economic objects." (Dillard, 1991, p. 20).

Table 3. Socio-Economic Objects within Capitalist Value Accounting Compared to Commons Value Accounting

Socio-Economic Objects	**Capitalist Value Accounting**	**Commons Value Accounting**
Human Labor	Commodity Value	Reflection of Species Being
Time	Continuous Made Discrete	Experienced Via Natural Body Processes

Institutions	Embodiments of Class Hierarchies	Reflects Individuals' Perceptions of Themselves
Transactions	Restricted to Narrow Prespecified Attributes	Incorporates a Broad Range of Social/Environment Attributes
Means of Production	Capital Dominates Labor	Labor Dominates Capital

(Manski, Sarah G. (2020). Distributed Ledger Technologies, Value Accounting, and the Self Sovereign Identity. *Frontiers in Blockchain,* 3. DOI: 10.3389/fbloc.2020.00029)

The logic of capitalism derives from the drive to maximize profit. What is produced is driven by what can be profitably sold on the market, and production decisions are made by the quite small category of people, capitalists, who own and control the means of production. The labor of production is completed by wage laborers who must sell their labor to capitalists to survive, as they receive bank-credit money in return (McCarthy, 2018). The problem with the logic of capitalism is that everything else, including healthy social relationships, a stable climate, having meaning in life, etc. are only considered part of the value equation when it impacts profit. Technological activists are rejecting the logic of capitalism and insisting on creating a world where humans and living systems thrive, and therefore are developing new ways to recognize value.

In Capital V1, Marx (2019) states what has value is only that which can be used to produce commodities that can be sold for profit in the market; this form of value is called *exchange value*. Such a market can only work with the existence of money as a material representation of value. It is the circulation of money as capital, the transformation of nature, and wage labor into

commodities that have *exchange value* that drives capitalist economies. Marx envisioned a mechanization process that we now call modernization by which scientific knowledge and technology come to be more important factors in production. Competition inspires technological and organizational innovations that make value unstable and a "perpetually evolving inner connectivity (an internal or dialectical relation) between value as defined in the realm of circulation in the market and value as constantly being re-defined through revolutions in the realm of production." (Harvey, 2018). "Forces of production and social relations – two different sides of the development of the social individual – appear to capital as mere means and are merely means for it to produce on its limited foundation. In fact, however, they are the material conditions to blow this foundation sky-high." (Marx [1857-8], 1993, p. 705-6). Technological innovations also involve greater systemwide complexity, which carries its own challenges in part because defining the concept of complexity is a matter of debate (Pryor, 1996; Rosser, 1999). Hodgson (2003) defines complexity as systemically interconnected and interactive variety within a structured system, "By this definition, increasing economic complexity means a growing diversity of interactions between human beings and between people and their technology." (p. 472).

Our institutions are challenged by increasing complexity, and the digitization of the economy has accelerated this process (DeSanctis & Poole, 1994). Massive amounts of information are available irrespective of geographic boundaries, and increasingly people have access to participation in a formal economy, which is governed by automated algorithmic systems communicating interdependently with each other. Humanity has attempted to solve coordination challenges in complex networks with systems of hierarchy, including monarchies, corporations, militaries, and representative democracies

with layers of bureaucracy, yet current economic and governance patterns are proving inadequate (Duit & Galaz, 2008). Markets have been proposed as a solution, but current market approaches are proving inadequate, because markets tend to have limited or lopsided communication patterns that do not contain information about all that is valued by society such as care work, environmental beauty, leisure time, etc. (Doane, 2002).

Price communicates across complex supply chains incredibly well, but the price of something is an oversimplified communicator of value. For example, when the price of copper goes up, the price of goods that use copper and the price of services that make use of those goods tend to go up as well. At the end of the line, a consumer can sense the difference between a supply chain that makes use of copper and one that makes use of a cheaper alternative because of the difference in sticker price at the point of purchase; the process by which 'the invisible hand' functions (Hayek, 1945). However, other forms of information, such as the working conditions under which the copper was mined, or the environmental record of the mining company do not get communicated across the supply chain with nearly the same level of fidelity. This imbalance in the composability of price information versus other forms of information leads to larger-scale effects that amount to a race to the bottom. The fact that price is the dominant form of information traveling with this level of efficacy is a challenge for technological activists and points toward potential technological solutions.

To overcome this problem, technological activists have asked, is it possible to increase the adaptive capacity of value accounting not just to single organizations but of markets more generally? The conclusion that many have arrived at is that what is needed is more rich and varied forms of information to be not only communicable but also

composable. Currently, the use of dollars is the only value metric that is highly composable across contexts (Krafel, 1999; Harris-Braun & Brock, 2018). Activists argue that what is needed are other ways that individuals and communities can communicate about value in ways that can be composed across contexts because whether something is valuable depends on the context.

There is a tension here between the recognition that value judgments are always communicated within specific relationship contexts. And yet, it can be useful to have that information be composable beyond those specific contexts and can also end up altering the dynamic of that initial relationship in the future. For example, there is now pressure for restaurants to create photogenic food that will make a nice picture on Instagram. Matt Schutte, Holochain Director of Communications, argues, "In order to thrive, we need to create value accounting systems that increase internal complexity." (Interview with Matt Schutte, 2019). He is part of a movement of technologists using ideas drawn from the field of cybernetics to explore new technologically enabled protocol cooperativism accounting systems.

Organizational theory states that organized systems must adapt to their environment in order to survive (Lawrence & Lorsch, 1967; Aldrich, 1979). W. Ross Ashby's (1961) Law of Requisite Variety, presupposes that "for any system is to be stable, the number of states of its control mechanism must be greater than or equal to the number of states in the system being controlled." Activists argue that we need new ways to coordinate in an increasingly complex global system. Technological systems that will enable advanced forms of social cooperation that form the principles of a new political economy, a global technological commonwealth. Their socio-technical imaginary of the economy is one in

which the primary role of production is to meet the needs of the community; the productive assets are held in common under democratic control; people work because it provides meaning in their lives, and; money is a mutual credit system specific to the community's needs.

3. Commons Economies

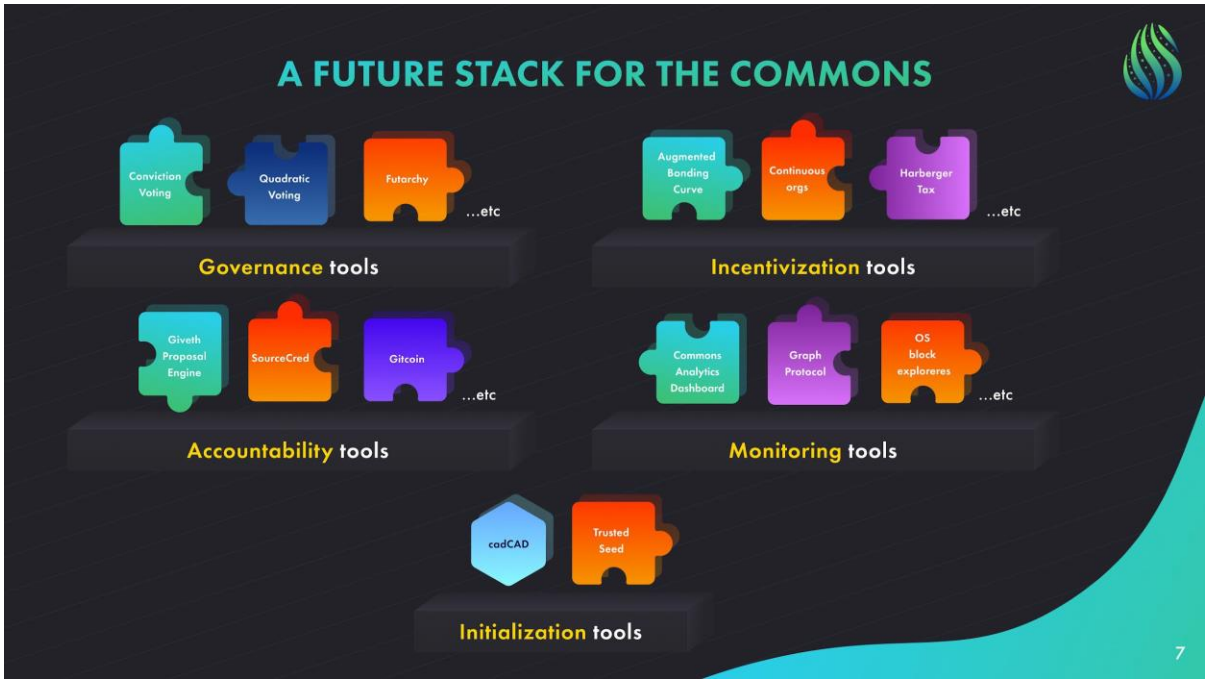
The commons can be managed in a sustainable way by local communities of peers when communities communicate to build common protocols and rules that ensure their sustainability (Ostrom, 1990). Distributed ledger technologies can be designed for the creation of self-sustaining commons economies where all participants profit according to the value that they produce rather than trying to conform to the capitalist economy. These are the 'cyber-physical commons' powered by blockchain networks, which are designed to align user incentives toward maintaining the network. Miners earn tokens, developers hold the tokens hoping their efforts will raise their value, and users purchase tokens creating demand and pay transaction fees.

Open shared ledgers are a key mutual coordination mechanism to shift open-source coordination from software to manufacturing. Blockchain and distributed ledgers generally enable open and contributive ecosystem accounting (such as practiced by the Canadian Sensorica project, 2019), REA (resource - event - agent), which let us see flows in shared circular economies involving multiple players, and biocapacity accounting, which is based on a direct vision of the flows of matter and energy. These types of contributory accounting systems promote fairness, openness, transparency, security, and environmental limits. The current state of the blockchain world is one of fragmentation, but the tools are in development for the creation of interoperable P2P ledgers.

a. Commons Stack

For example, members of the Giveth team are using blockchain technology for good by building a toolkit for creating these new community economies. The project is called the Commons Stack and is a collaboration with BlockScience, a Complex Systems Engineering R&D firm. The Commons Stack is a project started in 2019 that aims to create community tools to improve decentralized coordination around shared goals. In these 'community commons,' blockchain technology is used to align economic incentives with each communities' values and scale these previously underfunded communal efforts into effective networks for good. They believe the growth of the commons will be accelerated through access to an open-source library of modular, customizable, and interoperable components enabling purpose-driven communities to unite around shared goals (Diagram 2).

Diagram 2: A Future Stack for the Commons



(Diagram 2. The Commons Stack is building a library of tools for context-specific methods of governance, incentivization, accountability, monitoring, and initialization using holistic system simulations. Used with permission. Graphic by Jeff Emmet (2020), published in "Architecting the Cyber-Physical Commons" https://medium.com/commonsstack/architecting-the-cyber-physical-commons-a294d88b5415)

The Commons Stack project has identified components for what they term a 'Minimum Viable Commons,' to provide key functionality in coordinating a group around raising and allocating funds, making decisions, and measuring impact. The first component is the 'Augmented Bonding Curve,' providing continuous funding for a commons initiative through community transvestment, with growing academic foundations for this new economic tool. The second is a transparent and accountable proposal service, which they call the 'Giveth Proposal Engine.' The third is a novel process for continuous decision making modeled off the mechanics of a neuron firing in the brain, called 'Conviction Voting.' And, finally, a means to monitor and measure the value produced in these communities, they term the 'Commons Analytics Dashboard,' which they see leading to a future of Computer Aided Governance. The most important aspect of the Commons Stack is its emphasis on Token Engineering, including the use of an open-source complex system modeling and simulation tool called CAD (Emmet, 2020).

The Commons Stack is using the emerging discipline of token engineering to design technological improvements to streamline community fundraising and decision making, lowering the barriers for groups with shared goals to operate as distributed protocol cooperatives. They are doing this by producing design patterns for community toolkits, a library of code specifications and reference implementations. These designs will be chain-agnostic and can be applied to data-centric and/or agent-centric architectures, although most developer interest so far exists in the Ethereum ecosystem, so that is likely where they will see their designs first implemented (Emmet, 2020).

The Commons Stack could be the technological evolution needed to enable the growth of the commons by enabling cryptoeconomic systems of cooperation and governance. This modular 'cultural and technical stack for the commons,' could help communities reach shared goals by giving them the tools to bootstrap necessary funding (often the main hindrance to launch), and empowering that community with proportionally weighted peer governance, real-time preference signaling, and monitoring systems that respect complexity. By creating a growing library of open source component blueprints for governance, funding, and other critical infrastructure, the Commons Stack enables communities to act as effective platform cooperatives, co-owning and co-managing shared funds as a commons. These components can be combined to create intentional, circular, community-driven economies powered by continuous funding streams and transparent decision making, which will enable the threefold coordination of the post-capitalist economy (Emmet, 2020).

It is important to distinguish the concept of distributed ledgers from many current implementations of blockchain technology, several of which have structural and environmental issues that may or may not be overcome in future iterations. Hence, the global commons movement is paying close attention to post-blockchain ledgers, which have different underlying philosophies. For example, the Holochain distributed ledger does not aim for a single worldwide chain of transactions, in which every transaction needs to be verified with the total accumulating database of all global transactions. Instead, Holochain has a biomimetic philosophy[13], which allows for local and contextual open ledgers to connect with each other and become interoperable (Brock, 2019).

[13] The design of Holochain's architecture is inspired by natural systems because its creators believe billions of years of evolution have produced the model for resilient, sustainable, self-organizing communities.

F. Imagination

Chain technologies such as blockchain and holochain are in the early stages of reshaping the entire global economy and the social practices between individuals, organizations, and political institutions. The social and material worlds engage in the process of co-construction, and technology is always a combination of the technical, political, social, and economic. When a new technology is invented, as in the case of blockchain technology (Nakamoto, 2008a), new assemblages can be formed; some of which may favor social movement actors.

All technologies contain tendencies, a structured set of relations that enables or constrains different sets of possibilities (Winner, 1980). A technology's form allows or limits different human potential actions, and which properties are incorporated into a particular technology are determined through a process of negotiation between parties (Bijker, 1995). This negotiation process is shaped by the relative positionality of each actor and their ideologies. People's goals are often constrained by what they think is possible using particular technology (Leonardi, 2012).

Visionary social movement technologists recognize this fact and consciously work to expand 'the possible.' Jasanoff and Kim (2015) importantly bring imagination in the field of technology through their work on 'sociotechnical imaginaries,' which they define as "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by a shared understanding of forms of social life and social order attainable through, and supportive of, advances in science and technology" (p. 4). Chain technologies are enabling the construction of new sociotechnical imaginaries.

Jasanoff and Kim label technologist's utopian vision of the future the "sociotechnical imaginary" (2009). This phrase incorporates the concept of the 'sociotechnical' with that of the imaginary. In the field of Science and Technology Studies (STS) the term sociotechnical is used to indicate that technology is neither wholly socially determined nor deriving from an essential internal logic, "Technologies and technical practices are understood as durable (but not immutable) assemblages of social relation and technical artifacts" (Dunbar-Hester, 2019, p. 83). There is a lively discussion among technologists on how to use distributed ledger technology to realize a collective vision of a better future. Through interviews with technological activists, I have found agreement on several common components of a global technological commonwealth, the movement's emancipatory sociotechnical imaginary (Manski, 2017). This shared imaginary consists of a post-capitalist society where communities of mutual interest cooperate in the construction of institutions of regenerative economic relations. This movement of technologists has a strong faith in serendipity because they believe the necessary pieces will fall together if the correct intentions are directed outward and if the participants are mindful of the opportunities that can be pulled inward. These principles of technological design include:

- ➔ Technological design should incorporate planetary boundaries
- ➔ Technological design should be modeled on natural biological ecosystems
- ➔ Technological design should enable the redefinition of value
- ➔ Technological design should enable radically democratic coordination and governance
- ➔ Technological design should allow for the growth of a cooperative commons as the desirable future

There are interactive relationships between technologies and social systems (Mutch, 2002). The level of the empirical is the level of the observable, but the researcher should not ignore temporality. The structural conditions, including the technological materiality that were inscribed into the material form of the technology before the observed social interaction. Technology is a construction of the social in that particular human actors and organizations write their interests into the shape of the technology, creating pathways that enable and inhibit types of action. The degree to which an inscription inhibits an activity depends on the irreversibility of the inscription form (Mutch, 2002; Winner, 1980). Social actors can attempt to ignore specific properties of inscription, but real material constraints "can inscribe structural elaboration into relatively fixed properties that then form the social conditioning of the next round of social interaction." (Mutch, 2002).

Critical Realism is useful for global studies researchers because causality can instead be understood as the confluence of multiple sources of causal powers on an individual, local, national, and global scale. In open systems, people exhibit agency advancing their interests through the use of ideas, beliefs, language, and other cultural artifacts. Individual human agency occurs within the context of relationally constituted social structures that both enable and constrain activity. Humans are not reducible to their physical materiality; they emerge as social actors who operate in an open system conditioned by emerging structures (Archer, 1990). By identifying the causal powers, both how they work and under what circumstances they are activated, the researcher can explain social processes (Sayer, 2000).

This interdisciplinary research uses a socio-technical approach to look for patterns in how encrypted distributed ledger technology is used strategically by social movement actors. This critical research in the nature of collective sense-making and materiality is guided by Sheila

Jasanoff and Sang-Hyun Kim's (2015) comprehensive research framework of the sociotechnical imaginary. These imaginaries can be held by individuals or collectively in consortiums. The affordances of distributed ledger technology (Manski and Manski 2018) make possible multiple imaginaries.

1. Socio-Technical Futures

> *Futures, as well as pasts, are always parts of the present*. (Grunwald, 2019, p. 18)
>
> *Among the technologies predicted to "disrupt" our futures, one stands out as simultaneously exciting, terrifying, and overhyped: the blockchain*. (DisCO, p. 13)

Future scenarios in which technology is imagined to shape our political-economic institutions are called a socio-technical imaginary (Jasanoff & Kim, 2015). Jasanoff writes, "by inquiring into imagination as a social practice; we follow the embedding of ideas into cultures, institutions, and materialities, whereby the merely imagined is converted into the solidity of identities and the durability of routines and things." (Jasanoff & Kim, 2015, p. 323) By approaching technological innovation using this perspective, the researcher avoids the trap of technological inevitability (that the final form of technology was inevitable) or technological determinism (that a society's technology determines the development of its social structure and cultural values).

The researcher then moves to understand how individual's imaginations of an ideal future gain traction outside small bounded communities of like-minded activists in the embedding phase, "hybridization, or coproduction of ideas, materiality, values, and sociality" (Jasanoff & Kim, 2015, p. 322). Jasanoff writes that visionary actors must often attach their imaginaries onto "tangible things that circulate and generate economic or social value" (Jasanoff & Kim, 2015, p. 322). The researcher seeks to understand the process through which an actor takes their

imaginary and transforms it through labor and capital into an "organized field of social practices" (Appadurai, 1999) and material technology (Winner, 1980). Penney (2013, p. 21) writes that people "do the work of changing the world - but stories give us permission to reimagine it." Through embedding shared personal imaginaries into the construction of technologies that spread across space, time, and culture, groups attempt to construct meaningful translations from the present to the imagined ideal future.

There is a renewal of interest in the field of global studies in the role the imagination plays in shaping our vision of the future. Through the use of our imagination and anticipatory thinking, we can build a bridge from our current present to the desired future present. When we make statements about the desired future, we are making an intervention in the present (Losch, 2006), because of future scenarios, once articulated, influence political debate and policy decisions (Selin, 2007). Grunwald (2019) lists the main attributes of what he calls *techno-visionary futures* (See Box 3).

Box 3: Main characteristics of techno-visionary futures

1. They refer to a distant future and exhibit revolutionary impacts on culture and social institutions.
2. Scientific and technological advancements take a determining role in shaping modern society.
3. Their authors are highly educated elites, scientists, NGOs, or industry leaders.
4. Their high level of subjectivity leads to controversy. (Grunwald, 2019)

Because we cannot shape the future directly, we imagine the future and make decisions in the present that shape the future (Camhis, 1979). Studies of future imaginaries have been conducted in the fields of climate engineering, body enhancement (Roco & Bainbridge, 2002), nanotechnology (Fiedeler et al., 2010), and synthetic biology (Giese et al., 2014).

Future scenarios are social constructs created through a combination of available knowledge, value judgments, suppositions, normative and utopian visions. "They are communicated via different channels, journals, networks, mass media, research applications, expert groups...some will quickly disappear within these communication processes while others will survive and motivate actors" (Grunwald, 2019, p. 24-25). Socio-technical futures are constellations of imagined changes (or not) to future social, political, and economic institutions, processes, and cultures that are shaped by the interaction of people with technology. These changes can be global in scale or small but are created to be widely communicated visions of utopias or dystopias as an intervention in the present. While current technology is included in socio-technical futures, these futures are created by the human imagination, which is often sparked by emergent technology.

Many different types of people are engaged in developing socio-technical futures for various reasons. Policymakers want their policies to be effective; business leaders want to avoid unnecessary risks; authors want their material to be relevant; academics want to conduct research that will be cited, etc. The study of socio-technical futures is relevant to technology assessments as they can reveal implicit norms, values, power relations; "they give expression to certain desires, fears, goals, interests, states of social groups or individuals, and to the way in which they see themselves" (Losch et al., 2019, p. 293). The impulse to create socio-technical futures is often generated by the desire to solve a problem.

Techno-visionary futures have the power to shape government, social, and scientific pathways by partly articulating what future information and knowledge are available (Dupuy, 2007). It is important to recognize people engaged in imagining the future bring to this process their ideology, interests, and positions of power within society (Brown et al., 2000). Every network architecture hides a power structure, "we can be a lot more nuanced in the design and usage of technologies by being explicit about the values we imprint in our economic systems" (DisCO, 2019, p. 13). Thus, by examining future imaginaries, it is possible to tease out the underlying ideologies, interests, and power relations within the political economy of blockchain technology. Building a blockchain requires the technological design of software and hardware, as well as game theory and governance. In the process of building an organization for each blockchain-based project, the founders write a whitepaper. Whitepapers are a public document carefully written, proposing a technological solution to a current problem, and they are an excellent source of socio-technical futures for analysis.

2. Whitepapers

A whitepaper is an in-depth report on a specific topic that is written in an authoritative manner that is designed to persuade the audience to adopt a solution to a problem. A company whitepaper is different from a political whitepaper, which is a legislative document explaining and supporting a particular political solution. The audience was policymakers. For technology projects, the whitepaper is designed to convince their audience of the worthiness of each project. The audience could include investors, developers, potential partners, and end-users. Whitepapers often require significant time and resource commitment. The cost to hire an outside consultant to write a company whitepaper can start at $4,000 and run into tens of thousands of dollars because the audience expects authorship with a high level of expertise and fully referenced research and

data. The length of the whitepapers used in this research ranged from a few pages to several chapters. Generally, the whitepapers have a similar structure with a title page, table of contents, short executive summary, introduction, several pages educating the reader about the problem, several pages hypothesizing a solution, several pages offering an example of a company that used that solution to achieve results, and a conclusion. They often include supporting graphics and images.

Project leaders produce a whitepaper as a founding document of the organizations. The whitepaper will often include a statement of principles about the organization and a statement of the present and the future. Whitepapers are designed to reach other people outside of the organization and persuade them to take some action, "We want the DisCO Manifesto to reach as many people as possible. We've taken the time to describe concepts from the Commons/P2P, Open Cooperative, Feminist Economic, and Distributed Ledger Technology (or DLT) spaces. Each of these movements speaks to its communities in specific terms and cultural references" (DisCO, 2019, p. 12)

3. Method of Analysis of Whitepapers

The use of language is a social practice (Fairclough & Wodak, 1997), and critical hermeneutic discourse analysis is a research method that examines structures of language related to broader social, political, historical or cultural macro-contexts, which may provide insights into the present and future social practices (Wodak & Meyer, 2009). This dissertation is a technology assessment (TA) of distributed ledger technology that examines the socio-technical imaginaries of distributed ledger organizations and how these might shape economics, society, governments, and ethics in the future. As recommended by Maxwell (2013), I choose a qualitative method that

best fits the purpose of this study and addresses my research questions. Through the exploration of discourse, researchers can reflect on how society constructs concepts (Willig, 2003).

This dissertation builds from 25 interviews, many informal discussions with the founders of distributed ledger projects, and 141 distributed ledger technology whitepapers. This analysis reflects a 'sociology of knowledge' approach to discourse analysis (Keller, 2005, 2012) and initially included a grounded approach to these documents using qualitative data analysis (InVIVO), through which concepts, paragraphs, phrases, and speakers were manually coded. The coding does not cover the entirety of the documents, instead of focusing on the discourses on socio-technical futures. This analysis moves beyond simple textual analysis using a case study, observations, and even a dense ethnographic description to link the social, political, historical, and institutional dimensions of knowledge production and circulation (cf. Li et al., 2015). This study employs a reflexive hermeneutic approach by systematically comparing two types of socio-cultural tendencies in distributed ledger technological projects. Each tendency differentially frames whitepaper discourse. I analyze whitepapers from two groups of advocates, which I identify as "Technological Commonwealth" and "Corporate Capitalist."

This research analyzed the top 91 Corporate Capitalist whitepapers based on the distributed ledger technology-based projects with the highest market capitalization. These are found on the website CoinMarketCap.com, which lists the top 100 cryptocurrencies by market capitalization. Each cryptocurrency is linked to a distributed ledger project for which the cryptocurrency plays some role in maintaining the project. One of the CorpCap whitepapers (Holo) was included instead in the group of TechComm whitepapers, because it is ideologically aligned with those building a Technological Commonwealth, and eight of the top 100 projects either did not have a whitepaper or reused the Bitcoin or Ethereum blockchain whitepapers.

A whitepaper is often necessary for seeking venture capital investment, and as Technological Commonwealth projects are significantly undercapitalized compared to Corporate Capitalist projects, there are many fewer that have reached the whitepaper stage. Of the 250 Technological Commonwealth organizations, this researcher identified, only 74 were established enough to have a whitepaper.

Most whitepapers in both groups were written after 2013, and a third were written from 2017 to the present. The gender breakdown of the known authors was overwhelmingly male (one female lead author). Each case is a single distributed ledger project.

Coding

If concepts are important, they will be repeated (Strauss, 1987; Patton, 2002). Initially, I ran the auto code function in NVivo for each set (Corporate Capitalist whitepapers and Technological Commonwealth whitepapers). NVivo auto-generated 45 codes for the Corporate Capitalist whitepapers and 66 codes for the Technological Commonwealth whitepapers (See Appendix 1 for a list of the auto-generated codes for each set). I then created a list of theoretically derived, *A priori*, codes as sensitizing concepts rather than as fixed categories. The list of *A priori* concepts can be found in Appendix 2.

Each concept (i.e., democracy) was given a node in NVivo, and concepts such as capital* also recorded variations on the word, in this instance, the appearance of the word capitalism would also be recorded. The number of occurrences of each concept was recorded separately for both the set of Corporate Capitalist whitepapers (*CorpCap*) and Technological Commonwealth whitepapers (*TechComm*)(See Chart 1). For instance, capital* appears in the Technological Commonwealth whitepapers 384 times and appears in the Corporate Capitalist whitepapers 146 times. Interestingly, as the Corporate Capitalist whitepapers describe more projects that are

exclusively focused on creating cryptocurrency tokens, one might have expected the opposite result. However, because the word capitalism was also recorded, we see more references in the Technological Commonwealth whitepapers. This is due to the fact that these projects often define capitalism as a larger problem that needs to be addressed. For example, "We strongly believe that DisCOs can be a useful tool for the precariat in self-organizing into purpose-oriented collectives to foster economic counterpowers against predatory capitalism." (DisCO, p. 11).

Chart 1. The percentage of occurrences of each concept

The chart below details the number of occurrences in the "References" column and the percentage of occurrences in the "Reference per Paper" column, because the data set included 91 CorpCap whitepapers and only 74 TechComm whitepapers. There was no significant difference in the approximate length of the whitepapers between the two groups.

CONCEPT	CORPCAP/TECHCOMM	REFERENCES	REFERENCES PER PAPER	SOURCES
CAPITAL	Corp	146	1.6	32
	Tech	384	5.19	43
COMMONS	Corp	165	1.81	46
	Tech	339	4.58	53
COMMUNITY	Corp	741	8.14	65
	Tech	1090	14.73	60
CONSENSUS	Corp	914	10.04	49
	Tech	305	4.12	42
COOPERATIVE	Corp	25	0.27	16
	Tech	256	3.46	32
DECENTRALIZED	Corp	782	8.59	69
	Tech	724	9.78	49
DEMOCRACY	Corp	12	0.13	7
	Tech	83	1.12	16
DIGITAL	Corp	602	6.62	60
	Tech	653	8.82	60
DISTRIBUTED	Corp	702	7.71	67
	Tech	798	10.78	62
ENCRYPTION	Corp	194	2.13	29
	Tech	260	3.51	28
FUTURE	Corp	414	4.55	68
	Tech	404	5.46	64
GLOBAL	Corp	431	4.74	56
	Tech	740	10	61
GOVERNANCE	Corp	382	4.2	47
	Tech	901	12.18	61
IMAGINATION	Corp	31	0.34	20

	Tech	51	0.69	24
IMMUTABILITY	Corp	46	0.51	21
	Tech	81	1.09	31
MAINTAINER	Corp	277	3.04	60
	Tech	228	3.08	56
MINER	Corp	513	5.64	41
	Tech	63	0.85	21
PEER-TO-PEER	Corp	132	1.45	44
	Tech	196	2.65	41
PEOPLE	Corp	231	2.54	53
	Tech	510	6.89	63
PROBLEM	Corp	388	4.26	55
	Tech	376	5.08	60
PUBLIC	Corp	842	9.25	68
	Tech	945	12.77	63
SOCIAL	Corp	168	1.85	32
	Tech	569	7.69	54
SOLUTION	Corp	472	5.19	58
	Tech	648	8.76	59
SOVEREIGNTY	Corp	0	0	0
	Tech	18	0.24	8
STAKEHOLDER	Corp	284	3.12	23
	Tech	182	2.46	42
TRUST	Corp	533	5.86	66
	Tech	579	7.82	56
VALUE	Corp	1412	15.52	69
	Tech	1403	18.96	67
VISION	Corp	75	0.82	27
	Tech	117	1.58	30
WEALTH	Corp	33	0.36	17
	Tech	114	1.54	22

4. Results and Discussion

Reflecting on the result of the qualitative data analysis, this section distills divergent discourses on the future development of distributed ledger technology. The first subsection (1) critically examines conventional socio-cultural understandings of how distributed ledger technology is framed for future use in economic, political, governance, and social purposes by Corporate Capitalist whitepapers. The second subsection (2) examines the contrasting cooperative socio-cultural understandings of how distributed ledger technology is framed for future use in economic, political, governance, and social purposes by Technological Commonwealth whitepapers. The third subsection (3) then discusses this contrast in terms of the

seven affordances or tendencies of distributed ledger technology, which include: verifiability, globalist, liquidity, permanence, ethereality, decentralization, and future focus (Box 1, Manski and Manski, 2017). The fourth subsection (4) focuses on the contrast in future imaginaries between the corporate capitalist whitepapers and the technological commonwealth whitepapers. Subsection five (5) explains the hype cycle and exaggerated claims about the future found in the discourses of the whitepapers. There is a final discussion on themes of economic liberalism found throughout these whitepapers.

a. Corporate Capitalist Future

> *It is our vision that the future of blockchain is not only in a few billion-dollar worth of blockchains, but in billions of blockchains as well. This is a revolutionary change and we are excited to push forward a whole new economic era.* (V Systems).

The Corporate Capitalist whitepapers revealed a distinct socio-cultural understanding of how they believe distributed ledger technology should be put to work. This socio-technical future imaginary will be described below in general terms and then specifically in reference to the topics of people, globality, governance, meaning of money, democracy and nature. These topics tend to overlap. For instance, an author may be making a cultural statement about the meaning of money, etc.

<u>General</u>

The word consensus appears 914 times in the Corporate Capitalist whitepapers. Consensus here referred to the mechanism by which the data comes into agreement, rather than the common use as the term to refer to a group of people coming to cooperative agreement. For example,

"This novel requirement means that the protocol correctly and efficiently reaches consensus even if each of its step is executed by a totally new, and randomly and independently selected, set of players." (Algorand).

The word miner appears 513 times in the Corporate Capitalist whitepapers. The choice to use the word miner reflects Satoshi Nakamoto's libertarian ideology as he called blockchain maintainers miners (Nakamoto, 2008b). There are several ways to maintain the integrity of a distributed ledger including: proof-of-work, proof-of-stake, proof-of-cooperation, proof-of-creativity, proof-of-consistency, proof-of-contribution, proof-of-personhood, proof-of-humanity, proof-of-conscious, proof-of-ownership, proof-of-authority, proof-of-blood, proof-of-knowledge, etc. Each of these consensus mechanisms has implications beyond the distributed ledger, such as the amount of energy/waste required and the level of inequality/power created among users. Bitcoin mining is particularly environmentally destructive (Box 2), so as Technological Commonwealth projects tend to be more environmentally focused, they would be less likely to use the word mining as a way to describe their project's maintenance.

Overall, the Corporate Capitalist whitepapers were much more professionally formatted and included several legal disclaimers on the first few pages in an attempt to limit their liabilities. This is not to say that the whitepapers in the Technological Commonwealth group were poorly formatted, but fewer appeared to have paid an outside design and legal firms to construct their whitepaper. This can be expected as the Corporate Capitalist projects have greater access to capital, with a market capitalization ranging from $400,000 to $45,000,000,000.

A strong theme in the Corporate Capitalist whitepapers is that decentralization is desirable, and centralization is something to work against. For example, "Decentralization plays a more common role in our new cryptocurrency economy, but there is one area of the market that

remains centralized and vulnerable: the initial coin offering (ICO)." (Komodo). Along these lines, many projects mentioned that open technical standards win over closed ones, "The biggest support as an open source project would come from its own users, who are interested in it." (Bytecoin). Also, a large volume is preferable to small scale solutions, and reflecting a pro-capitalist sentiment, anything that causes market friction is bad, "A proven system for evaluating and rewarding contributions is the free market." (Steem). Market and economic growth are good, "We believe in a future of multiple digital assets, each with unique comparative advantages that enable them to play distinct roles in driving economic growth and in diversifying investment portfolios." (Ethereum Classic).

Another capitalist belief is that efficiency is a goal in itself, "The promise of advertising technology ("ad-tech") was to create a more efficient marketplace for attention." (BAT). Here are two more examples of discourse on efficiency, "Indeed, early calculations indicated that the energy requirements of the protocol were comparable to that of a small country. This state of affairs has motivated the investigation of alternative blockchain protocols that would obviate the need for proof of work by substituting it with another, more energy efficient, mechanism that can provide similar guarantees." (Cardano) and "Blockchain-enabled prediction markets reduce bottlenecks associated with contract fulfillment, manipulation, and provide better transparency and dispute resolution than traditional prediction markets." (Hedge Trade).

In general, the scope of the socio-technical imaginary was more limited than in the Technological Commonwealth whitepapers. The main focus of these whitepapers was convincing the reader that this protocol design is an improvement on existing blockchains, for example, "This paper introduces various concepts to improve the design of bitcoin resulting in

improved privacy and fungibility for the average user, less price volatility and quicker message propagation throughout the network." (DASH).

People

Discourse on people and how they should interact with new technology can reveal current attitudes regarding how much control people should hold as individuals. Are people users, peers, maintainers, stakeholders, co-owners, consumers, prosumers, etc.? How people were discussed varied significantly between the Corporate Capitalist whitepapers and those of the Technological Commonwealth. In the Corporate Capitalist whitepapers, individual agents are deemed to have clear and persistent boundaries, existing in a Euclidean economic space where they relate to each other via linear transactions. Human rights are narrowly considered in these whitepapers, "We believe that it's your basic human right to control your money, data, and identity." (MCO).

People are defined both internally and externally by their economic activity, "This reward and automated verification system greatly enhances a trader's credibility, motivation to succeed, and earning potential." (Hedge Trade). People feel emotions and a sense of self-worth through their use of technology, "Using Enjin Coin will promote a culture of passion, collaboration, and pride by giving players more control over their game content. Players that feel valued will keep coming back and increase revenue and engagement for publishers and content makers." (Enjin).

People are consumers and products. Every aspect of our humanity is open for commodification, including our attention, BAT calls for "A New Deal: Attention-based Economics on Blockchain...user attention is valuable, but it hasn't been properly priced with an efficient and transparent market system." (BAT). In the Status whitepaper, they explicitly say that the user will no longer be a product, but what they mean is that the user will no longer be a

product without getting paid for being a product, “We recognize that in a model where the User is no longer the Product, paying for push notifications may initially seem like a hurdle, as Users in existing platforms currently get this ‘for free.’ Instead, we make the costs explicit to the User and don’t exclude possibilities where a push notification node could build a business on top of the infrastructure, i.e., offer the service ‘for free’ by the User viewing ads to pay for push notifications. The end result is that we give the User a choice.” (Status).

Along these lines, there is a strong belief that we should be making more profit off of the untapped value in everything, everywhere, “Our longer-term vision is to broaden the usage of BitTorrent far beyond current use cases to provide a distributed infrastructure platform to third-party app developers and to enable consumers to continuously distill small amounts of value from their devices by allowing others to make use of their spare resources.” (BitTorrent), and “Ethereum Classic is a next-generation blockchain platform for a new internet infrastructure – one that can dramatically enhance the ways that information and value are shared in the digital economy, unlocking trillions of dollars in untapped economic surplus in the process.” (Ethereum Classic).

Who is a person in the socio-technical imaginary of the Corporate Capitalist often meant those who have money to spend, “There are many forms of Freedom that Komodo can provide, and we are currently focusing on empowering two types of users: the blockchain entrepreneur, and the average cryptocurrency investor.” (Komodo). The implication is that those without money to invest are not important. For example, the Horizen Academy whitepaper discusses providing free education to users, but only to those who can use cryptocurrencies, “The Horizen Academy provides free education around the topics of blockchain technology, online privacy and the Horizen project itself. The goal is to lower the cognitive barrier to entering the ecosystem,

and to provide educational resources to make the experience of using cryptocurrencies and blockchain technology better." (Horizen).

True to Nakamoto's original Bitcoin whitepaper (2008a), there is the underlying belief that individuals are not trustworthy. The ultimate goal is to create trustless systems, where the trust is placed in the presumably incorruptible technology, "The introduction of blockchain technology has brought trust to the masses through shared access to decentralized information. Blockchain has not just built trust in individual projects - it has fundamentally changed the future of trust ecosystems." (Ontology), "Stakeholders can deposit SNT against usernames at a premium, creating a badge indicating a level of value that username holds and the amount of backers they have. This will allow us to establish a base Web of Trust, which will give an indication of how reputable a username is within the network, and this can be further developed in the future." (Status).

Technology can also align incentives among people, "Despite each playing a critical function, these parties operate with vastly different goals in mind and current models fail to provide a means by which their incentives can coexist and be aligned." (Status).

Privacy is a strong concern in the Corporate Capitalist whitepapers. Many of these projects promised to protect users from Big Government, Big Corporations, or Other Users, "Verge is completely User-controlled and decentralized which insures that at no point in time is your transactional meta-data going to be shared or sold to independent 3rd party corporations. When you make a purchase with Verge, your personal privacy is kept safe." (Verge), and "Horizen is built from a community with a strong ethos of privacy being a natural right." (Horizen).

Globality

Of all the subjects of discourse, globality, the view that the increasing interconnectedness of the globe is good, was the most strongly shared among the Corporate Capitalist and Technological Commonwealth whitepapers, "The rapid advancement of this technology has begun to blend world borders and statute, providing glimpses of an improved, alternative future." (ICON), and "The ICON Project began with the goal to enrich our everyday lives through 'connection'...ICON embraces the new and the unfamiliar, the principle of radical inclusion – accept new ideas and decisions made by the new republic established by ever-changing crypto-to-real world connections." (ICON).

The main point of divergence between the discourse on globality between the two sets was that the Corporate Capitalist whitepapers were focused on removing geographical and the associated regulatory barriers to the economy, "By integrating BTT tokens and transaction processing we will both address existing limitations of BitTorrent and open up a whole new borderless economy exchanging value for compute resources on a global scale." (BitTorrent), and "Bytom aims to build a global open platform for registration of byte assets" (Bytom), and "Borders and jurisdictions may become less relevant as more assets become tradable and trading across borders grows increasingly frictionless. In an age where people can move significant amounts of wealth instantly using Bitcoin, global consumers will likely demand the same efficiency for their securities and similar asset holdings." (Ravencoin).

Governance

In the sociotechnical imaginary of the Corporate Capitalist projects the dwindling importance of the nation-state due to globally distributed ledger technologies leads to the twin beliefs that governance must be both global and technology-based, "The software is part of a holistic

blueprint for a globally scalable blockchain society in which decentralized applications can be easily deployed and governed." (EOS). Governance is best left to technology, "What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party." (Bitcoin), and YAP Chain claims their Smart City technology will provide 'credibility and communality,' "YAP Chain is a blockchain optimized for Smart City which is an urban operational system for organizations, shopping malls, and cities that will issue YAP Stone, and through the issuance of YAP Token, smart contract and DApp based on credibility and communality will be provided." (YAP).

Decentralization is an ideal in the Corporate Capitalist whitepapers, "We believe that modularity not only enables upgradable systems but facilitates decentralization." (ChainLink). "It is our hope that these tools will enable decentralized social and economic systems that bring people together and empower the human spirit." (Horizen), and "The vision of the ICON Project is to introduce the new era of decentralization by redefining the meaning of communities and creating a new world by connecting such communities. Communities today are commonly defined by their social and political functions and limited to the economic boundaries set forth by world nations. Through ICON, communities can go beyond and be free from the traditional economic system and promote frictionless value exchanges with other communities, eventually resulting in maximum total utility of society." (ICON).

The ultimate vision of decentralized governance is the DAO, "one of our main aims is to adopt decentralization principles not only in our technology but also in the management model." (ABBC Coin). Decentralized Autonomous Organizations or DAOs as they are most commonly called are open, self-organized networks coordinated by crypto-economic incentives and self-

executing code, cooperating around shared goals. They consist of a class of smart contracts designed to automate the execution of organizational governance. Smart contracts were made real through the creation of Ethereum, a blockchain network that permits Turing-complete computations (meaning it could be used to solve any computation problem). By deploying DAO contracts into the Ethereum blockchain, organizations could theoretically allow participants to control funds and vote on subsequent funding allocation with governance rules that are formalized, automated, and enforced by the conditions encoded into a smart contract.

While traditional smart contracts are aimed mostly at delivering automated outcomes as they perform financial functions, DAOs differ by structuring a set of decisions that cannot be automated away and instead require some form of conscious attention for their functioning. The argument goes that by encoding rules into immutable, self-executing systems, human error and messiness could simply be designed out of institutions, making our futures more reliable and trustworthy.

In the sociotechnical imaginary of the Corporate Capitalist whitepapers, the metric of good governance is measured through economics, "There is a growing base of quantitative and qualitative research evidencing a positive relationship between good governance and the long-term performance of traditional assets." (Ethereum Classic), and "Robin Hanson's futarchy, a mechanism for organizational governance via prediction markets, is a good example of what truly "autonomous" governance might look like." (Ethereum).

When governance is merged with economics, participation in governance is wholly dependent on holding capital. Horizen states their governance goal is, "influence that scales with skin in the game." An example of this type of blockchain maintenance is Proof-of-Stake, which means that only users holding a certain number of tokens can participate in governance. For

example, the following is Hedge Trades' vision of decentralized dispute resolution, "The process will begin by automatically notifying a randomized selection of high-ranking users that have opted to join dispute resolutions. Each qualified user must then stake HEDG tokens to cast their vote on whether the Blueprint in question was correct or incorrect. Users that vote on the side of the majority will be rewarded with HEDG tokens." (Hedge Trade). Also, in order to contact other members of the network, users must hold tokens in the network, "Inspired by one of Satoshi Nakamoto's original suggested use cases for Bitcoin, we will be introducing an economics-based anti-spam filter, in our case for receiving messages and "cold" contact requests from users. This enables stakeholders to set a minimum amount of SNT that a Status stakeholder must deposit in order for someone outside of their network to contact him directly. If the recipient replies, the deposit is forfeited to the recipient." (Status).

Meaning of Money

The discourse in the Corporate Capitalist whitepapers uncritically embraces the 'free market,' "A proven system for evaluating and rewarding contributions is the free market. The free market can be viewed as a single community where everyone trades with one another and rewards are allocated by profit and loss. The market system rewards those who provide value to others and punishes those who consume more value than they produce." (Steem).

As seen in the above section on governance, in the Corporate Capitalist whitepapers, money equals the right to participate (i.e., pay to play). The discussion assumes that everyone has money they control, "The Teller Network allows Stakeholders in the Network to find nearby users to exchange their cash for digital assets and currency, giving any smartphone owner in the

world the ability to take control of their personal wealth. In this sense, Status becomes a piece of a “Web 3.0” banking infrastructure and creates a global people-as-ATM network.” (Status).

A strong theme throughout the Corporate Capitalist whitepapers is that money should not be controlled by the banks or government, “Bitcoin was created for many different reasons and every day, people find new reasons to adopt Bitcoin. One of the historical reasons is that people do not trust states or banks or any such intermediaries to control their money...We want Bitcoin to be a shared and independent currency. We don’t want any fat cat to drive our monetary architecture.” (Bitcoin Gold).

Taken to the extreme, ideally, money should not have any human interference, “Bitcoin was created for many different reasons, and every day, people find new reasons to adopt Bitcoin. One of the historical reason is that people do not trust states or banks or any such intermediaries to control their money...We want Bitcoin to be a shared and independent currency. We don’t want any fat cat to drive our monetary architecture.” (Bitcoin Gold), or "In an ideal world, in which we could count on a universally trusted central entity, immune to all possible cyber-attacks, money and other financial transactions could be solely electronic." (Algorand).

At the same time there is a push to ‘tokenize’ everything, meaning assign a unit of exchange to everything, ‘tokenization’ of assets and rights are being accelerated, and as a result, the dynamics of cross-border connections is being redefined, “Existing currencies, tangible assets such as real estate and automobiles, intangible assets such as patents, copyrights, and trademarks, our legal rights such as voting rights and citizenship, and even DNA data or blood test results can benefit from tokenization. This forces us to rethink everything, even obscures the space-time boundary, and makes distinguishing tangibles from intangibles meaningless.” (ICON). Paxos Standard elaborates on this vision, “The promise of the concept is a fluid, digital asset that can

easily move anywhere, anytime, in a trustworthy way with the universal understanding of exactly how much value it represents." (Paxos Standard). Of course, in this sense, the word 'value' is used in the capitalist sense to mean exchange value.

Democracy

The word democracy joins two Greek words 'demos' and 'kratia,' meaning the people have power. It was only mentioned 12 times in the Corporate Capitalist whitepapers, as compared to 83 times in the Technological Commonwealth whitepapers. For the projects that did mention democracy, they meant that all users within the project network would have the ability to participate, "Algorand's approach is quite democratic, in the sense that neither in principle nor de facto it creates different classes of users (as "miners" and "ordinary users" in Bitcoin). In Algorand, all power resides with the set of all users." (Algorand).

This concept of democracy is not 'one person, one vote.' Instead, it is 'one token, one vote' as the Status project explains, "One major drawback in legacy social networks is the lack of influence their users possess over the networks themselves. They are often powerless in having a say on how the platform evolves. We aim to democratize this power, giving stakeholders a direct influence over all decisions within the network, including how the software is developed. A core part of the Status Network Token is giving stakeholders the ability to choose the direction that the software is developed. The token is used to make decisions on proposals, which can be made by any Stakeholder. For each decision, the token is cloned into a separate decision token. The amount of tokens you hold at that time becomes your voting power for that decision, and it does not cost SNT to vote." (Status).

The Horizen project stands out among this group because it has the strongest interest in democracy, “It is our goal to render this process fully decentralized such that any ZEN holder can shape the future direction of the project.” and “The system is governed by a diverse group of stakeholders in a decentralized, transparent, and collaborative process that balances interests, gives everyone a voice, and democratically allocates resources...The Horizen team is committed to building a better, more inclusive future for society by providing tools that empower our users. This type of distributed, user-owned network offers a new way of bringing people together, creating and sharing value, and giving voice to everyone by participating in a common ecosystem built on a shared public infrastructure.” (Horizen).

Nature

Throughout the course of this research, a surprising pattern of nature as a metaphor appeared in both interviews with technologists and in the discourse used in the whitepapers. It was unexpected that the people who are most deeply enmeshed in the digital world are looking to the natural world for design inspiration. For example, “ICON is inspired by Gilles Deleuze and Felix Guattari’s rhizome.” ICON is a project designed to connect multiple sidechains, enabling cross-platform data and value communication, and at the beginning of their whitepaper one finds this quote from Mille Plateaux, Gilles Deleuze and Felix Guattar, “A rhizome has no beginning or end; it is always in the middle, between things, interbeing, intermezzo. The tree is filiation, but the rhizome is alliance, uniquely alliance. The tree imposes the verb "to be," but the fabric of the rhizome is the conjunction, "and ... and ...and..." This conjunction carries enough force to shake and uproot the verb "to be." Where are you going? Where are you coming from? What are you heading for? These are totally useless questions.” (ICON).

Unus Sed Leo brings the natural world into their project's name, "Our company motto, Unus Sed Leo, is a Latin citation from Aesop's fable, "The Sow and the Lioness." The fable (in short) details how a sow brags about how many children she has and then asks the lioness if she only had one child. The lioness replies "One, but a lion." This ethos of quality over quantity and individual strength extends across several elements of iFinex, from being a privately-owned company to our recruitment and operational infrastructure." (Unus Sed Leo).

b. Technological Commonwealth Future

The Technological Commonwealth whitepapers revealed a distinct socio-cultural understanding of how they believe distributed ledger technology should be put to work. This socio-technical future imaginary will be described below in general terms and then specifically in reference to the topics of people, globality, governance, meaning of money, work and labor, democracy, and nature. The whitepapers in this group discussed work and labor to a much greater degree and trust to a much lesser degree than the Corporate Capitalist whitepapers.

General

The Technological Commonwealth group is not monolithic, but they do share a distinctly different socio-technical future imaginary from the Corporate Capitalist projects. Technological Commonwealth projects are often mobilized around issues like sustainability, the circular economy, and they are working on making systems of production more ecologically sustainable. They are attempting to create a more cooperative, socially just, solidarity economy. This is accomplished through the sharing of knowledge, code, and design in globally scaled networks of collaboration. This is referred to as the 'global technological commonwealth' (Manski, 2017). These three movements are engaged in experimental, prototypal, and pre-figurative practices and

are using and strategically developing new types of technological tools with affordances fitting their needs (Manski & Manski, 2018). In this process they seek to escape dominant technologies which exacerbate inequalities and limit human potential.

The word ‘commons’ appears 339 times in the Technological Commonwealth whitepapers in contrast to 165 appearances in the Corporate Capitalist whitepapers. The meaning of the word ‘commons’ contains three components. First, the commons are a shared resource (hence a common “social object”). Second, the commons are collectively created or maintained as a resource. Third, the management of that resource is guided by community rules and norms (i.e., auto-normativity) (Manski & Bauwens, 2020). For example, “The commons is an ancient idea that certain things should not be owned, but be available for anyone to use, such as air, the oceans, or a field on which villagers can graze their cows” (Credit Commons).

The group of Technological Commonwealth projects is commons-based in that they are open, productive communities, an ‘entrepreneurial coalition’ (Waters-Lynch, 2018), sharing a desire to organize production around the commons. They believe the commons can be managed in a sustainable way by local communities of peers when communities communicate to build common protocols and rules that ensure their sustainability (Ostrom, 1990). They are designing distributed ledger technologies for the creation of self-sustaining commons economies, ‘cyber-physical commons,’ where all members of a community benefit, “Our team believes in the power of large-scale, community-powered applications to change the world for the better, beginning with our alternative to cloud computing — crowd computing. We are building both community and technology.” (Holo).

Those within the Technological Commonwealth believe they “stand at the crossroads of various movements: open source, the commons, permaculture, platform and open cooperatives,

blockchain, intersectional feminism and feminist economics, open-value accounting. Individually, the change-making movements we take part in offer alternatives to the deficiencies of mainstream economic thought, but to address the root causes of inequality, we need accessible frameworks that unite them." (DisCO, 2019, p. 65).

Generally, those projects in the Technological Commonwealth express a greater concern for social problems outside of their project. For example, "Another downside is that the system increases inequality: the rich can afford to install a lot of computing power, by which they get even richer because they obtain a large share of the reward. Because of that, there is even a dangerous tendency towards mining monopolies or oligopolies, where big mining farms buy smaller competitors until only few (or one) very large players are left." (Viridian).

Those founders of the Technological Commonwealth projects are part of post-capitalist movements, such as Buen Vivir, the Social Solidarity Economy, Municipalism, Ecofeminism, Decolonialism, Degrowth, the Maker Movement, Permaculture and anti-austerity protest movements are expressly building towards a post-capitalist world, "Changemakers want to change the status quo...They embrace alternative economic models that prioritize community and sustainability over fast growth: Circular economies. Farm to table. Local, organic farming. Artisanal economies. Social capital. Natural capital." (Proof of Impact).

The appearance of the whitepapers is generally shorter with less standard formatting.

The whitepapers of the Technological Commonwealth mention decentralization (724 times) almost as much as those in the Corporate Capitalist group (782 times). In this group of projects, decentralization is for the greater good, "As the work from Balaji Srinivasan on quantifying decentralization demonstrates, "centralization" and "inequality" have striking similarities; one can think of a non-uniform distribution of wealth as highly unequal, and a non-uniform

distribution of power as highly undemocratic, or centralized. A similar calculation can be made to measure how democratic is a DAO." (Democracy Earth).

People

"We humbly make the commitment to strive every day to improve as individuals, as human beings, and to promote the adoption of collective values that improve our relationships. We are convinced ethic's main values: justice, responsibility, integrity, respect, honesty, equity, are the basis of constructive relationships." (EthnicHub).

In general, the people make more of an appearance in the Technological Commonwealth whitepapers, "Ethic Hub relies on technology, but people remain the motor of its operations" (EthnicHub). The word community is mentioned 349 more times in the Technological Commonwealth whitepapers (1090 times) as compared to those in the Corporate Capitalist group, "As a community-run coin everybody has a part to play in the success of the pink coin family" (Pinkcoin), and there is a rejection of the neoliberal individualism, "DisCOs are associationist instead of individualistic and based on building trust rather than confirming laboratory-tested game-theory hypotheses." (DisCO, 2019, p. 27).

Also, the word 'people' appears 510 times in the Technological Commonwealth whitepapers as compared to 231 times in the Corporate Capitalist whitpapers, and the word 'public' is slightly more prominent, appearing 945 times (TechComm) compared to 842 times (CorpCap). The word 'social' is mentioned 569 times in the Technological Commonwealth whitepapers as compared to the Corporate Capitalist whitepapers (168 times).

The authors of the Technological Commonwealth whitepapers focused on prioritizing mutual support, cooperativism and care work among people, "Open-value cooperatives apply the logic

of feminist economists like Marilyn Waring, to account for the care work vital to human prosperity and survival." (DisCO, 2019, p. 8). People are not thought of as users alone or consumers who need to be convinced to give up their money; instead, these projects start from the perspective that organizations are created to further empower the people they serve, "Ethics should become a part of the conversation in the blockchain universe." (Amazonians Green Coin). People here are trusted to engage in cooperative behavior, rather than being distrusted. In the associated milieu of the networked tribes of the 21st century, "we are always already at stake with each other, partnered all the way down. Inhabitants of the world, earthlings and earthbound, creatures of all kinds, human and non-human, we are entangled in a series of interlaced trails and creative feedback loops, holding open life for one another." (ESA).

Users have increased agency and control, "We disfavor the term 'beneficiary' as both disempowering and patronizing. We refer to the people in aid-receiving communities as the primary constituents of development." (Pando). They can be both producers and consumers, "The work ahead lies in creating a decentralized, efficient way to manage new prosumers and billions of devices coming to electric power ecosystems." (Exergy). Women are empowered, Prefiguration of the utopian society you want to live in, "Callisto envisions a world where sexual assault and harassment are rare, and survivors are supported in their pursuit of justice. The reporting experience should be empowering for survivors and should rebuild their sense of agency. Authorities should have the data they need to prevent assault and stop serial perpetrators."

The design ethos for those projects in the Technological Commonwealth group is to make technology easier to use for the non-expert, "Our mission is to create a symbol for the common man to be able to participate in this struggle against Climate Change, while also utilizing the

revolutionary blockchain technology to do so." (ClimateCoin), "At Ecochain, we believe that there is a smarter way of organizing things by means of advanced simplification while keeping scientific rigor. In doing so, our technology can be used by a wide audience which extends beyond the LCA specialist. In this way, we fulfill our purpose: 'Enabling everyone to make sustainable change.'" (Ecochain), and "We aim to bring blockchain technology from "boutique" to "industry" in the energy sector, enabling pioneering market and business models that provide clear societal, environmental, and economic benefits." (Energy Web).

In contrast to the Corporate Capitalist whitepapers, which focused on the individual as the most important agent, these whitepapers reject the neoliberal idea of the individual, "DisCOs are associationist instead of individualistic and based on building trust rather than confirming laboratory-tested game-theory hypotheses." (DisCO, 2019, p. 27). They imagine a world where communities of people practice of mutual aid; cooperation and community service are rewarded, "Within the cooperation network, both donors and supporters will be motivated to participate in blood donation activities and they will be rewarded for such activity through services directed to the network (medical examinations, dedicated diets, gift cards, access to sport and recreation centers, insurance under special conditions and other incentives)." (BloodChain), and "DiSCOs can more effectively embed a culture of inclusion in our future organizational forms and technologies, making room for diverse experiences and expressions while respecting boundaries, and creating dignified livelihoods." (DisCO, 2019, p. 65).

Globality

The word 'global' appears 740 times in the Technological Commonwealth whitepapers as compared to those in the Corporate Capitalist group (431 times), "If we are to strive for a

blockchain utopia, we need more than an agenda. We need a genuine global answer on who guarantees the system, as well as consider how this can be underpinned by "good" at its heart." (BC4G). Another example from DisCO, "While physical production is kept local and needs-based (following the "Design Global, Manufacture Local" logic), knowledge, resources and value flows are shared at the global level with like-minded enterprises to create political and cultural counterpower to the prevailing corporate/ capitalist economy." (DisCO, 2019, p. 33).

Around the globe, there are more than 4,000 developers contributing code across 2,800 public blockchains every month. (Electric Capital, 2019) and these developers do not believe people should be limited by traditional nation-state borders, "Econauts will navigate these financial and futurial borderspaces that are not hard and bounded - liminal spaces that allow you to fold yourself within and without." (ESA), and "Everyone should be able to create their own nation, everyone should be able to create their own reality, both global and local, which neither, again, no nation-state is providing for us." (Interview with Bitnation founder, Susanne Tarkowski Tempelhof). There is also a distrust of nation-states, "Entry Data is "not discoverable," meaning that it is protected from litigation or investigation discovery requests (including subpoenas served to Callisto)." (Callisto).

Counterintuitively, one of the leading projects in this area is backed by the nation of Estonia, "A new digital nation e-Residency is building a new digital nation for citizens of the world where no-one is held back from their entrepreneurial potential because of where they choose to work or reside. This has enormous potential for unlocking global growth by democratizing access to entrepreneurship and e-commerce. We believe that countries will one day compete for e-residents based on the quality of their public e-services and their business environment" (e-Estonia).

Not only are the project teams geographically dispersed, but the legal organization of these projects is global, “We have been operating as an international community-controlled initiative since 2015 with full transparency - in the form of a registered non-profit organization in Spain and Hungary and a limited company in the UK.” (Envienta), and “we moved jurisdictions from Gibraltar to Liechtenstein because there apparently was some scare in Liechtenstein, some ICO doing shady things last week and there was like some feedback coming down against the regulatory authority” (Interview with Arthur Brock, 2019, Holo founder).

Also, many of the projects describe the affordance of globality a feature that enables their technological solutions to social problems, “Ethic Hub is a global crowdlending platform that enables access to groups of small producers from developing countries to lower rate loans than the ones now available to them, benefiting both parties from this exchange.” (EthnicHub) “Build a platform to unite basic income initiatives worldwide.” (Horizon), “EverID is building the Identity Network (IN): a non-profit stewarded identity and value transfer network for the common good of the planet. Self-funded, transparent, and independent, The IN supplies the protocol & infrastructure for every human being to own & control their own database of identity data, including their biometrics.” (EverID), and “Another advantage of our app is that it provides communities that are involved in carbon projects a way to engage and interact with consumers globally, thus creating a platform that will bring those responsible for the forests on the ground closer to those interested in their protection.” (Poseidon).

Governance

“We need to find ways to embrace not only technical solutions, but also people who have experience in community organizing and methods that foster trust, negotiate hierarchies, and

embrace difference. Because there is no magic app for platform cooperativism. And there never will be." (O'Dwyer, 2018).

While a majority of the projects in both groups made some mention of the governance protocols of their distributed ledger technologies, interestingly the word 'governance' appears 2.4 times more frequently (901 times) in the Technological Commonwealth whitepapers compared to the Corporate Capitalist whitepapers (382 times), "Despite the idea of unbiased machine governance popular of late we see very few, if any, of these systems functioning well. None of them have been able to escape human social reputation. Instead, we've opted to design a distributed ledger that embraces the qualities of our existing social reputation systems. If an actor with supposedly good reputation starts behaving maliciously, they can quickly lose the support of others. This can be abused too; but at least there is the opportunity to adjust one's trust in others based on feedback and reasoning." (Regen).

Those whitepapers in the Technological Commonwealth group focused on democratic and cooperative governance by people with the assistance of technology, "Holo is also a hosted commons with expected standards of behavior. The full complement of social agreements simply cannot be encoded into smart contracts." (Holo), "Consensus protocol is designed to enable the implementation of a social layer built on top of distributed ledgers that can deploy borderless democracies, Universal Basic Income mechanisms and credit scores, without the need to sacrifice privacy and using social markers that incentivize participation on the blockchain economy to earn rights." (Democracy Earth), and "Humankind lacks a network where participants can collectively govern, develop, and fund large scale projects such as missions to the Moon or solving global challenges. The Space Decentral Network seeks to make participation in such projects more accessible by offering a suite of open source tools, data, and

foundational knowledge. With a curated toolset, training material and a unified vision, being able to spend time working on our collective celestial dreams will no longer be a privilege, but a human right." (Space Decentral).

Distributed ledger technology seems uniquely useful for encouraging collaboration amongst diverse stakeholders. Many of the founders of Technological Commonwealth projects have participated in open source projects with the ICAA and Linux nonprofits. Created in 1998, ICANN, the Internet Corporation for Assigned Names and Numbers, is a non-profit corporation managing the Internet's global addressing system, and the Linux Foundation is a non-profit organization which promotes, encourages collaboration and provides the standards for Linux, "Not only is our open-source technology development collaborative by nature, but the way we operate and bring together developers, regulators, and energy companies (our "ecosystem") is collaborative by design." (Energy Web).

Previously, it was noted that decentralization is valued in the Corporate Capitalist whitepapers. This affordance is also discussed in the Technological Commonwealth whitepapers, but they purposefully use the word distributed rather than decentralized. As shown in the image below, distributed systems disburse power between the nodes to a greater extent. "The cryptoeconomic projects we are collaborating with (ECSA and Holochain) both try to build on the possibility that blockchain created of having a system where finance and sociality (or, in more conservative terms in the crypto lingo, "governance") are entirely integrated and decision-making power is distributed and non-hierarchical. The question we are facing is: How do we operate at this juncture in ways that prefigure the altereconomy to come, using the tools we presently have? How do we prefiguratively institute the ethos described in this working paper now?" (3E Process Seed Bank).

Centralized control of data is a problem for those who want to ensure an ethical supply chain such as the Provenance project, “A typical server room storing company system data. In it’s current centralized format, there are many weaknesses. In the face of these efforts, we must ask ourselves: can one organization be trusted to broker all data about every product’s supply chain? The truth is that no single organization can and that relying on one party (or even a small collection of cooperating parties) creates an inherent bias and weakness in the system.” (Provenance).

One criticism of Bitcoin is that membership is often defined by stake ownership, enabling large holders to swing votes according to their own preferences, “Bitcoin’s original White Paper description of “one-CPU-one-vote” shaped the industry to think governance centered around machines, not people.” (Democracy Earth).

The whitepapers in the Technological Commonwealth group seek to clearly communicate to the broader public why they will benefit from using this technology, “If we’re integrating blockchain technology into government infrastructure, it is essential that we focus on deployment in places where it is needed most. It is important that decision-makers and policymakers are properly engaged.”; Blockchain for Good writes that one of their goals is “bringing to justice criminals committing crimes against humanity” (BC4G). Another example is from BITCUB, “From a user perspective, additional benefits include a more streamlined process for accessing finance, low-cost remittances, better interest rates on savings and loans, the ability to get credits from fellow community members and earn in the process, engaging new products for children and partaking in a global community with a genuine focus on inclusion, development and wealth fostering.” (BITCUB).

As governance through the nation-state is seen as a relic of the past, federated governance following the shape of the development of distributed ledger technology and the commons movement is promoted, "What was clear from our conversation is that regardless, we do require a federated model - a guiding hand, to set the vision and principles to enable its success, for the greater good - whilst allowing verticals or countries to govern their specific areas. To be clear, this is not a government, a centralized organization, or even regulation - but policy and principles that document a duty of care for blockchain technology." (BC4G).

Governance in the Technological Commonwealth moves beyond simple representation to mutual aid, "The type of accountability mechanism we have created is grounded in a concept of mutual accountability. In essence, mutual accountability says that those working in aid hold each other to account for equitable, inclusive relationships that are meant to enhance local leadership and self-reliance while realizing improvements to human wellbeing and habitat sustainability." (Pando).

Meaning of Money

We could be building an economy of abundance. (IXO Foundation).

Many of the whitepapers in the Technological Commonwealth start from the assumption that the current economic system is dangerous, "The ecological crisis facing humanity is the result of failing to account for the aggregate impact of decisions initially made for increased efficiency, profit, and comfort. This process of externalizing costs causes degradation of common resources" (Regan).

The word 'wealth' is mentioned 114 times in the Technological Commonwealth whitepapers as compared to the Corporate Capitalist whitepapers (33 times). With a focus of wealth instead

of profit, these projects are promoting commons ecosystems with positive feedback loops offering reciprocal rewards to people who provide value to the community. To this end, blockchain's affordances enable the possibility of supply chain transparency, "Contribution to OriginTrail ecosystem is a pledge towards more transparent, collaborative, fair and trusted supply chains." (OriginTrail), and "Ecochain makes environmental impact transparent." (Ecochain).

In the process of imagining independent regional economies, founders of distributed ledger projects influenced by organizations such as the Schumacher Center, whose members attend the major blockchain conferences. The Schumacher Center, like the commons movement, is calling for new institutions of land, labor, and capital. These new institutions should be shaped by free associations of consumers and producers, working cooperatively, sharing the risk in creating an economy that reflects shared culture and shared values, "Small in scale, transparent in structure, designed to profit the community rather than profit from the community, they can address our common concern for safe and fair working conditions; for production practices that keep our air and soil and waters clean, renewing our natural resources rather than depleting them; for innovation in the making and distribution of the basic necessities of food, clothing, shelter, and energy rather than luxury items; and for more equitable distribution of wealth." (Schumacher Center 2020).

As the first use of blockchain is mainly a cryptocurrency, it makes sense that many of the whitepapers feature discussions on the future of money and value, and approach finance with a hacker attitude, "finance is not primarily about money: it is a mode of coordinating the future and its emerging possibilities through the collective design of attractors and the distribution of flows of desire...the Economic Space Agency is crafting a new platform, Space, to take up a

unique economic, ethical, aesthetical and political challenge: reinventing finance as a collective practice of crafting futures and rethinking value at the end of the economy as we know it." (ESA).

One of the most innovative aspects of distributed ledger technology is the ability to tokenize the protocol layer of information technology and the internet, which allows for a new economic model to emerge. This maintenance model can be designed as open-source, cooperative, and distributed with the value of the token representing access to that underlying infrastructure, "The Token aims to leverage this economic power and blockchain technology to advance equal rights and full acceptance for all members of the LGBT+ community worldwide." (LGBT Token), and "Each time a child is vaccinated, there is a new token issued. Every time a TB case is treated or a pound of plastic is taken out of the environment; there are corresponding tokens issued." (Proof of Impact).

In this way, finance can become a form of collective self-expression in the Technological Commonwealth, "The power of finance in our hands doesn't need to be just about raising funds or making money. It can be an invitation to risk and speculate together to open up new possibilities and modes of coming together." (ESA). This also would mean that communities will have the freedom to choose their own currency system with appropriate estimates of value, "because value is purely relative to each individual." (Duniter).

This collective economic self-expression is also a form of resistance to capitalism, "DisCOs have a nuanced vision of profit based on community control. If we define ourselves as "not-for-profit," we mean not for absentee or shareholder profit, but for the benefit of participants in the collective and its social mission. DisCOs are a framework for economic resistance achieved by creating economic counterpower." (DisCO, 2019, p. 60).

There is a bottom-up approach to community stability in the Technological Commonwealth, "WFP prioritizes working through and strengthening the local financial ecosystem." (BuildingBlocks). Additionally, in the Technological Commonwealth group, there was a focus on charity and profit-sharing, "10% of all profits will always be used for charitable causes, sponsoring and fostering wealth creation in the most deprived communities on the planet." (BITCUB) with a protocol for fair value exchange, "There is no central authority setting economic policies or regulating the distribution. As such, the incentive for action is open and put in the hands of everyone as there is a fair value exchange." (BC4G), and no government restrictions should be placed on individuals' use of currency, "WFP now aims to extend the value proposition of Building Blocks to explore unrestricted cash inside the refugee camps in Jordan to explore how the platform can support wider unrestricted cash distributions, starting with mobile money inside the refugee camps." (BuildingBlocks).

In the Technological Commonwealth, financial speculation is discouraged, "we are optimizing Holo fuel to function as a medium of exchange currency, rather than a store of value currency. In the process of building a thriving crypto-economy, credits need to circulate rather than be retained as a speculative investment" (Holo). In capitalism, money is "a tool in the service of the wealthiest players." (Credit Commons), but in the imaginary of the Technological Commonwealth, "We think that a money system could be considered a commons" (Credit Commons).

In the Technological Commonwealth poverty is eliminated and people receive services based on need rather than the ability to pay and as such there is a rejection of competition-based distribution, "a currency which aims to respect each individual's economic liberties MUST implement the Universal Dividend (a.k.a. Basic Income), which is the only way to avoid both

spatial and temporal asymmetry toward money issuance." (Duniter), and "The initiators of V believe that a basic income serves as an ignition to activate all human potential that remains restrained under the current monetary system." (Value Instrument). Maintenance of the distributed ledger should not increase inequality but be based instead on proof-of-cooperation, "Version 1 of the FairCoin wallet software which was used from 2014 until 2016 relied on mining and minting technology to secure the block chain. Our objection is that neither mining nor minting can truly be considered fair, because both confer an advantage on the already rich. Therefore we decided to create a new version of FairCoin which corrects these issues." (FairCoin).

Work and Labor

Unlike the whitepapers in the Corporate Capitalist group, the whitepapers in the Technological Commonwealth group often explicitly discussed a transformation of the meaning of work and labor, "What is the future of work? Restoration." (DisCO, 2019, p. 65). There was an acknowledgment that labor under capitalism is alienated and a goal to make work rejuvenating, "All 3E participation should be felt to be creative, and yield surplus-value of life." (3E Process Seed Bank). Also, there is a rejection of the social category of 'wage laborer,' "DisCOs spotlight a new political subject apart from "the worker" or "the precariat": the commoner, a person who co-manages their resources in a community according to the norms of that community." (DisCO, 2019, p. 67). They imagine a world where an individual's needs are no longer associated with work, "this project is all about trying to create an opportunity for a large group of people to find a way to a more meaningful life. Every bit of financial support

could help lead the way to new insights, less worries and hopefully more smiles and happiness." (Horizon).

The sharing economy and peer-to-peer economics are lifted up, "BloodChain will be based on Shared Economy and the technology that supports it in the best way, i.e., blockchain." (BloodChain), "VALID will be designed as a not-for-profit, peer-to-peer platform." (Procivis), and "Holo lets people use their web browser and existing payment systems to interact with decentralized crypto-apps and currencies, providing a bridge from Holochain's fully peer-to-peer world of the future back to the semi-centralized world of today." (Holo).

Patriarchy in general and in the workplace is rejected, and unpaid care work is valued, "Feminist Economics proposes a more holistic approach to the very idea of "the economy," factoring in often-invisibilized and unpaid factors such as care work, human connection, interdependency and emotional labor into economic theory." (DisCO, 2019, p. 32).

Democracy

The word 'democracy' and its variants such as 'democratize' is mentioned 83 times in the Technological Commonwealth whitepapers as compared to only 12 mentions in the Corporate Capitalist whitepapers, for example, "Restart Energy is building a global energy supply platform using blockchain protocol to democratize a sector burdened by bureaucracy and transaction costs, freeing up capital, saving consumers money, helping small local producers earn more and allowing real peer to peer direct energy trading using existing infrastructure." (Restart Energy).

The Hara project's imaginary is democratic and pragmatic, "Most crypto projects tout the fulfillment of crypto-anarchist ideals of total decentralization and automation of agreements, yet fail to provide an easy path for normal people to reach those ideals." and "A combination of AI

and blockchain is unleashing the next phase of our mission: to democratize data for the world's most socially impactful sectors." (HARA).

The idea of democracy was also seen in other discourse, such as, "we will enable a more participative energy paradigm" (Exergy).

Nature

OriginTrail is not a company; it is an ecosystem. (OriginTrail).

Those whitepapers in the Technological Commonwealth group also include metaphors from nature in the descriptions of their technology design process, "V is inspired by nature and its cycle of creation and decay. Through their observations of apple trees, the initiators of V realized that the system of abundance in nature could be translated to technology and aid a system for exchange between humans. Drawing the analogy of an apple tree versus V, V works like this: the token-issuing smart contract governed by a community is the sun, the token-wallet is the tree, the token is the apple. If not used, the apple drops to the floor, rots, and disappears - so does the token. But by picking and consuming the apple, it nourishes the recipient as a reward for the good or service, and its value lives on - so does the token." (Value Instrument).

DAOstack also looks to nature and other living systems as a guide for designing technological systems, "Decentralized structures are abundant in nature. The human body is a decentralized structure made of organs, sub-organs and sub-sub-organs, all the way to the atomic cells, which themselves have their internal structure. The functionality of the body is pretty decentralized, and no cell instructs other cells what to do. Rather, each cell is autonomously operating according to inputs it receives from its environment. The sense of an organism—an autonomous and sential human being, is an emergent phenomena apparent only at the collective

level." (DAOstack), and "Not following the rules gives you more choices without bottlenecks. When you operate from an agent centric reality, that's how the world works anyway, there is no central ledger in my body that all of my cells are reporting to coordinate their state. Each cell embodies its own state." (Interview with Holochain founder, Arthur Brock, 2019).

The Regen Foundation looks to nature in the design of the governance protocols of their project, "Regen Foundation's governance is founded on the understanding that humans in conscious relationships with ecosystem functioning can engage in systemic developmental co-evolution. The Foundation's mission is to explore the use of technology to grow human capacity to understand, value, and incorporate ecosystem health into our accounting and decision making across all governmental, corporate, and citizen activities." (Regan).

Many authors of the Technological Commonwealth whitepapers suggest distributed ledger technology provides the technological foundation needed to both transparently track ecological data and incentivize shifts in land use toward more regenerative practices. This vision of the future combines environmental concerns with globality, "responsible food production, easy food traceability, and effective ways to prevent food wastage due to overproduction. Our vision is to provide a sustainable solution to the Food Supply industry by developing simple, readily accessible software solutions and propagate Food Traceability all the way to the small and marginal farmers in Asia and around the World, ultimately winning the trust and confidence of the consumer." (Farm2Kitchen).

The Regen Foundation takes a similar approach to traceability, "We must create the ability to explicitly track the ecological impacts of our actions right alongside the financial. Taking a decentralized approach to this aim requires an ecosystem of organizations, each with its own important role. Regen Foundation will spearhead the scientific research and infrastructure

development necessary to create transparent and open Ecological State Protocols. Regen Consortium and the Community Staking Pools will act as the democratic body that stewards the ledger and the cultural shift towards true-cost accounting. And, Regen Ledger will be the domain-specific blockchain acting as the transparent balance sheet for Earth." (Regen).

The temporal scale of the imaginary in the Technological Commonwealth whitepapers spans several future generations, "We have the ability to reroute a trajectory towards a livable planet for future generations" (Regen), and "Part of our ecology will be hard-wired into the technological universe for generations to come." (Amazonians Green Coin).

In the whitepapers in the Technological Commonwealth group, environmentally sustainable living is available to everyone, not just those elite members of society in advanced nation-states, "We envision a vibrant, sustainable world where affordable energy is created and consumed by anyone anywhere." (Restart Energy), and "Energy Web Foundation's overarching objective is to accelerate the global transition to a decentralized, democratized, decarbonized, and digitalized resilient energy system." (Energy Web). Climate Coin seeks to enlist everyone in slowing the processes causing climate change, "The first cryptocurrency that allows everyone to participate in the fight against Climate Change. Creating value by incentivizing environmentally responsible businesses and sharing the results through our tokens." (ClimateCoin). Other projects were also working to slow climate change, "agriculture holds the potential to become a massive net carbon sink, sequestering billions of tons of CO2 per year into the world's soils and above-ground biomass. Land stewardship (farming, ranching, forestry), as well as ocean management (fisheries and mariculture), are the key intervention points to reverse these flows of carbon." (Regan).

In the Technological Commonwealth whitepapers, distributed ledger maintenance should be environmentally friendly, “Wherever possible, the mining times and environmental footprint is seen in Bitcoin and Ether based transactions will be avoided.” (BITCUB).

There was a recognition in the Technological Commonwealth whitepapers that the affordances of new technologies will share the environmental landscape, “We believe that the proliferation of smart devices will ultimately result in a requirement for device-enabled environmental impact mitigation, via self-regulated Smart Contract interfaces.” (Earth Token), and “A more efficient, resilient, and participative electric power ecosystem has never been more needed as our world transitions into a more dynamic and uncertain political, technological and environmental era dealing with the transition to a low carbon and highly automated future.” (Exergy).

c. Contrasting Concepts

Box 4: Contrasting Concepts in Socio-Technical Future Imaginaries

Concepts	**Socio-Technical Future Imaginary**	
	Corporate Capitalist	*Technological Commonwealth*
General	Techno-deterministic. Technophilic.	Includes the social within technological systems.
People	Should be commodified (by choice).	Individuals are members of communities. Individuals should not be commodified.
Globality	Increasing interconnectedness is good. Borders and regulations are bad.	What is heavy is made locally, what is light (digital) is global.

Governance	Global governance by technological systems. Pay to play.	Community governance. Local chains. Everyone affected participates.
Meaning of Money	Assumption everyone has money. State or bank (or human) control is bad. Value = Exchange. Tokenize everything.	Commons-based economics; resources shared cooperatively. Abundance is possible. Equitable distribution of wealth.
Culture	Move fast, break things.	Value justice and equality
Democracy	One token = one vote.	Local, cooperative decision making
Nature	Little to no concern for wasteful DLT maintenance.	Respect thermodynamic thresholds. Do not waste or destroy. Has independent value and agency outside of its human use value.
Temporality	The present.	Several future generations.
Work and Labor	Capitalist. Wage labor.	Non-alienated. From each according to ability, to each according to need.

d. Hype Cycle

THE REVOLUTION WILL BE TOKENIZED...The revolution can now begin. (Mattereum).

We at ENVIENTA believe that - with the right tools - technological progress can bring abundance, wellbeing and unlimited wealth to people. (ENVIENTA).

A joke I have often heard at blockchain conferences is someone joking saying, “Put it on the blockchain!” after being told a problem as if blockchains are the solution to every problem. The joke is funny to insiders because there are so many hype statements and excitement about this new technology. Blockchain is a panacea. An example from the HARA whitepaper, “Data is addressing a range of societal issues and creating a more prosperous, safer, and healthier future for the next generations...Data empowers billions and levels the playing field for everyone.” Or another from BC4G, “Given blockchain technology fundamentally changes existing structures, in our view, this is not merely an evolutionary development, but it has the potential to become transformational technology.” (BC4G).

I think this extreme level of hype is in part because distributed ledgers have almost unlimited possibilities for applications, and the early adopters of the first application, Bitcoin, became fabulously wealthy. These crypto-millionaires and billionaires have a strong sense of loyalty and community centering around distributed ledger technology. Hype discourse was found throughout all the whitepapers I examined, and while there was some overlap, it generally fell into four categories of topics: first are comparisons to the Internet, second are claims regarding the power of decentralization, third is the hype surrounding the potential for distributed ledger technology to change the nature of value, and forth are hype regarding power, organization, and governance.

Distributed ledger technology was compared most often to the Internet. The following excerpts are a few examples.

“Blockchain technology is, perhaps, the single most exciting innovation with enormous implications for revolutionizing products and services, comparable to the invention of the Internet.” (Nexo).

"The development of blockchain technology and cryptocurrencies represent a cryptography and security breakthrough as significant as that created by the internet in the 1990s." (Crypto.com Coin).

"Blockchain is the second internet revolution, doing for value and business what the Internet has done for information and media. It allows unprecedented levels of crowd coordination by eliminating altogether the issues of fault and trust." (DAOstack).

"Just as HTTPS, SMTP and SIP allowed for free information sharing and communications, crypto assets and blockchain technology will allow humans to exchange value and transact with one another in the same way: instantly, globally, securely and at low cost. An open internet of value exchange can transform and integrate the world more deeply, eventually eliminating artificial economic borders and enabling a more efficient and inclusive global marketplace that connects every person on the planet. The future of the global economy is open, shared, inclusive, far more evenly distributed, and powerful not only for a few chosen gatekeepers, but for all who will connect." (USD Coin).

Much of the hype discourse also focused on the distributed nature of the technology.

"True blockchains are used by many and owned by none." (Energy Web).

"The advent of the blockchain technology has introduced the world of decentralization and is challenging our preconceived perspectives of the current social, political, and economic systems, most notably, the central banking system. The rapid advancement of this technology has begun to blend the world borders and statute, providing glimpses of an improved, alternative future." (ICON).

"The Komodo project focuses on empowering users with Freedom through blockchain technology." (Komodo) "The consensus mechanism invented by Nakamoto is perhaps one of the most powerful innovations of the twenty-first century." (Komodo).

An additional focus of hype concerned the potential for distributed ledger technology to change the nature of value.

"Blockchain technology changes everything. The practical consequence […is…] for the first time, a way for one Internet user to transfer a unique piece of digital property to another Internet user, such that the transfer is guaranteed to be safe and secure, everyone knows that the transfer has taken place, and nobody can challenge the legitimacy of the transfer. The consequences of this breakthrough are hard to overstate." (Marc Andreessen, Inventor of the internet browser, CoinDesk, 2017).

"we think of the financial derivative as a technology to amplify the power of autonomous organizations, once it is used in the context of self-created economic space and made accessible through easy user interfaces and ready-made templates. These financial instruments organize — weave together, distribute, branch — economic flows, and thereby create new modes of relation — modes which were previously unavailable, impossible, or even nonexistent." (ESA).

"For most of history, only people or organizations have had the capacity to conduct economic transactions. Through unique and trusted digital identities combined with software-driven "intelligence," blockchain can enable physical assets to participate directly in markets without the need for a human intermediary...This is a powerful foundation for digitalized and distributed ownership, market participation, and wholly new profitable economic models." (Energy Web).

A subset of the hype on the changing nature of value is found in the way 'nature' will be re-valued by distributed ledger technology. "The ability to tokenize the information and data layer of this ecological ledger is key for functionality, but the larger disruptive potential of this new economic paradigm that is being ushered in by blockchain is the tokenization of specific living ecological capital assets." (Regen)

"For the first time in its history, the Amazon rainforest is opened up as a scalable and sustainable reserve." (Amazonians Green Coin).

"Poseidon has developed a platform that allows you to turn the negative environmental impact of every purchase you make into positive climate action. This is possible through a revolutionary integration that connects you directly to forest conservation projects, allowing you to make micro-donations with a measurable impact." (Poseidon).

"We believe that one of the highest potential uses of blockchain-enabled decentralized governance, crypto-economics, and distributed computing is to bring forth a game-changing paradigm shift in the relationship between financial systems and ecosystem health." (Regen).

Finally, there is a substantial amount of hype regarding power, organization, and governance.

"You are in control if you #bLockchainiT" (Land LayBy).

"Imagine cities where everything runs smoothly without depending on the unreliable human effort." (CitiOS).

"Blockchain networks opened the possibility of new institutional models built with open source code, able to resist censorship and scale participation globally." (Democracy Earth).

"Blockchains carry the promise of a more inclusive and universally accessible world, a world in which community participants and common folk get an equal opportunity to participate, and share, in the value that they create." (Earth Token).

“This is a historic moment. Following the emergence of blockchain and decentralized digital technology, social, economic and financial forms are becoming for the first time integrally programmable.” (ESA).

“Smart contracts are poised to revolutionize many industries by replacing the need for both traditional legal agreements and centrally automated digital agreements.” (ChainLink).

A subset of the hype discussing power, organization, and governance was specifically referring to Decentralized Autonomous Organizations or DAOs as they are most commonly called. DAOs are open, self-organized networks coordinated by crypto-economic incentives and self-executing code, cooperating around shared goals. They consist of a class of smart contracts designed to automate the execution of organizational governance. Smart contracts were made real through the creation of Ethereum, a blockchain network that permits Turing-complete computations (meaning it could be used to solve any computation problem). By deploying DAO contracts into the Ethereum blockchain, organizations could theoretically allow participants to control funds and vote on subsequent funding allocation with governance rules that are formalized, automated, and enforced by the conditions encoded into a smart contract.

While traditional smart contracts are aimed mostly at delivering automated outcomes as they perform financial functions, DAOs differ by structuring a set of decisions that cannot be automated away and instead require some form of conscious attention for their functioning. The argument goes that by encoding rules into immutable, self-executing systems, human error and messiness could simply be designed out of institutions, making our futures more reliable and trustworthy.

“The DisCO’s cousins, the Decentralised Autonomous Organisations, promise to allow people to exchange economic value, to pool resources and form joint-ventures, without control

from the centre, in ways that were impossible before blockchains; to agree on how risks and rewards should be distributed and to enjoy the benefits (or otherwise) of the shared activity in the future." (DisCO, 2019, p. 7).

"We believe DAOs will radically change the way people organize, from startups to corporations, to nonprofits and even nation-states." (DAOstack).

"Along with the basic principles of Decentralized Autonomous Organizations [Seth Bannon], which are complete transparency, total shareholder control, unprecedented flexibility, and autonomous governance, this approach delivers a higher number of benefits. Starting from a much faster and more efficient decision-making process, in comparison to the typical corporate structure, and ending with psychological factors. DAO users aren't just investors or token holders, but also the disruptors of the business model that use the power of their voices." (ABBC Coin).

"An automated custodian is the perfect legal counterparty to a smart contract. An automated custodian becomes an asset's legal owner and registrar, maintaining the authoritative register of interests in the asset. This enables the unbundling of legal ownership, financial beneficial interest, and possession or use of the asset. The tokenized beneficial interest in the asset becomes tradable, and use becomes licensable using smart contracts or utility tokens." (Mattereum).

e. Contrasting Future Imaginaries

Discussion of Results

The findings rely on grounded theory-based interpretations of the transcribed interviews and whitepapers combined with computer-aided content analysis.

Geertz (1973) recommends the researcher attempt to gain a deeper understanding of the culture the subject is trying to express using a 'thick description,' which moves beyond the verbatim transcript to include a wider semiotic analysis.

The socio-technical future depicted in the whitepapers is contextually bounded by the current historical socio-political moment. The following discussion highlights socio-cultural and institutional contexts of discourse on the future design of distributed ledger technologies contrasting corporate capitalist and technological commonwealth initiatives.

This researcher does not want to engage in oversimplification of complex and dynamic discourse on distributed ledger technologies. However, a caricature of the contrast between corporate capitalist (1) and technological commonwealth (2) projects may be useful to provoke discussion.

Corporate Capitalist Perspective

In the Corporate Capitalist whitepapers, there is a strong concern for using distributed ledger technology's affordances to avoid market, monopoly, or regulatory friction and unlock previously inaccessible areas for profit. In the words of Nexo, "The business model of Nexo is to provide instant crypto loans in order to unlock the value of the digital assets owned by its clients." The phrase 'unlocking value' is key, and everything, including our minds and bodies, should be commodified (i.e., tokenized). This is the goal of the Basic Attention Token project, "make attention no different from substitutable commodities such as pork bellies or crude oil, in the final analysis." (BAT).

The role of technology is both idealized and deterministic. Progress is linear. Distributed ledgers are heralded as revolutionary tools with awesome powers to solve problems. People and

institutions are mostly absent from the scene. When they are present, distributed ledgers can be used to avoid having to trust the person on the other end of the transaction. ABBC discusses trustless voting where "the user can proxy her vote trustless without handing over any keys." Users play a role as individuals with access to the required capital, knowledge, and technology in the Corporate Capitalist future imagined. And, while they depend on nation-state services such as the enforcement of laws and maintenance of individual safety, the role of the state is only discussed with regard to how its power can be circumvented. The authors of the Algorand whitepaper write, "The ability to "print money" is one of the very basic powers of a nation-state. In principle, therefore, the massive adoption of an independently floating currency may curtail this power."

The decentralization of distributed ledgers that allow for global flows of capital is discussed in a positive light; with no mention of the impacts this may have on the nature of work. The normative principle around the governance of such projects is that governance processes should be encoded into technological protocols to the greatest extent possible. An implicit normative principle aligns with Silicon Valley's 'move fast and break things' ideology. Other normative principles are that markets and economic growth are good, and people must 'pay-to-play.' This concept of democracy is not 'one person, one vote.' Instead, it is 'one token, one vote' as the Status project explains, "The amount of tokens you hold at that time becomes your voting power for that decision, and it does not cost SNT to vote." The world as it currently exists is good, and as such, there is no discussion of ethics, justice, inequality, environmental destruction, or other political-economic problems. In the Corporate Capitalist imaginary, we live in the ever-present now. Their orientation to the future is one of the unlimited natural resources, and there is very

little concern for environmentally destructive and wasteful distributed ledger maintenance. What really matters is making money.

Technological Commonwealth Perspective

The Technological Commonwealth whitepapers start out from the position that the political-economic system of the world is irrevocably flawed, and many large institutional changes spanning the globe are needed for humanity to reach its positive potential. This imaginary's assumption is that technology has a significant, but not singular, role to play in this process of rebuilding social, political, and economic institutions. In the technological commonwealth whitepapers, there is a strong concern for people. This includes both the people within their project network, people holding their tokens, and people outside of the project. People are often discussed as members of a larger community. They have rights and should live in a world that rewards justice and equality. The people in the future imaginary of the Technological Commonwealth have agency and, for the most part, should be trusted. People are not discussed as self-interested, profit-seeking, atomized individuals.

The affordances of distributed ledger technology excite the authors of the Technological Commonwealth whitepapers as they do those authors of the Corporate Capitalist whitepapers but for different reasons. Many of the Technological Commonwealth authors are a part of the larger cooperative commons-based economic movement, and they share the normative principles that there can be an economy of abundance, including a universal basic income, and that resources should be cooperatively managed and enjoyed by the entire community. Governance in this future is done best locally, but in cooperation with the larger world when dealing with global commons resources. Everyone who is impacted by decisions should be encouraged to participate.

Also, markets can and should be ethical, which also means that costs cannot be externalized, because thermodynamic flows and ecological limits must be considered.

The increased transparency and traceability afforded through distributed ledger technology should be used to grow trust in both the market and in people. The authors of the Credit Commons whitepaper write they are, "building new tools for work, rewards, and reputation which eschew monetary exchange and valuation. All those working in solidarity economy enterprises meeting human needs and minimizing abuse of the environment and our co-habitants in it." (Credit Commons). Those in the Technological Commonwealth are using the affordance to create ethical supply chains and reputation systems. "Companies might be willing to lie to make their product worth more if they can get away with it (e.g., about whether it contains materials that are harmful to the environment). It is, therefore, necessary to incentivize parties to only share correct information, and to hold them accountable when they don't." (Circularise).

The tokens made possible through distributed ledger technology are being used to incentivize positive social behavior, like vaccinating a child or treating disease. Self-sovereign identity enabled by distributed ledgers is put to work helping refugees and the poor and refugees without personal identity documents or land titles prove who they are and what they own. The distributed nature of the ledger's maintenance is taken advantage of as a means to build institutions outside of capitalism and strengthen community governance. For example, the Holo project is building a distributed Internet outside of the corporate-owned server infrastructure where 'the crowd becomes the cloud.' DAO capabilities are imagined automating cooperative management and grow the cooperative movement.

Beyond being a metaphor for design, the natural world should not be destroyed or wasted in the Technological Commonwealth's future imaginary. In the words of the Amazonians Green

Coin project, “we fight actively against deforestation, poverty, global warming, and climate change.” (Amazonians Green Coin). The authors are concerned about limiting the most devastating effects of the extraction economy, such as climate change, and imagine constructing an economy designed for the regeneration and growth of the commons.

What future would you like to live in?

Economic Liberalism

I was surprised to encounter a significant amount of economic liberal ideology in the technological commonwealth whitepapers. Examples of economic liberalism included extolling equal opportunity (as opposed to equal outcomes), “We believe in a world with equal access to opportunities, and we want to contribute to make equal rights to every citizen of the world a reality. Correcting misallocation of global capital is our project’s main motivation, but also correcting many of the unfair aspects of the current financial system. Within our system, fees are conditioned to the real value of contributions so they are charged only in case of loan repayment.” (EthicHub). And that inequality could be solved by providing an opportunity for inclusion into existing circuits of capital, “Providing financial inclusion to those more than two billion adults currently excluded from the global financial system, has a large untapped potential, both for economic development and business profit.” (Everex).

There were uncritical discussions of increasing profit and that growing capital and promoting human prosperity were linked and not at odds, “this will reshape our economy and create new economic opportunities. Pursuing this path has immense potential to generate profits, grow capital, mitigate business risks, create resilience and promote human prosperity.” (IXO Foundation). Many economic liberal references included the assumption that social and

environmental problems were not properly priced and should be linked to market-based solutions, “SolarCoin is more than a reward system for solar energy production, Solarcoin puts protecting natural capital at its foundation. The concept of “natural capital” aims to value the world's stocks of natural assets (geology, soil, air, water and living things) by making it investable.” (SolarCoin), “A root cause of our escalating ecological crisis is the failure to assign a monetary value to natural capital, which consists of the ecosystems that nurture life on earth.” (Heyerdahl Climate Pioneers (TREE), “This means that—for the first time—there will be a truly market-driven price on removing one tonne of carbon dioxide from the atmosphere...Burning fossil fuels has enabled positive outcomes including lifting billions of people out of poverty, increasing global trade, decreasing global violence, and increasing food production.” (Nori) and “Blockchain technology can be applied to mitigate collateral socioeconomic damage caused by economic activities; it requires market-based infrastructure that supports decentralized peer-to-peer interactions, the public network evaluation of negative impacts, the distribution of liability, and settlement by means of mitigation instruments.” (IPCI).

The economic liberal belief of ‘life stylism,’ that individuals can have a significant impact through their consumption, also was present, “EMPOWERING PEOPLE TO SAVE THE PLANET WITH EVERY PURCHASE...Once our solution is fully operational, retailers will be able to offer carbon credits with every product and service to mitigate and rebalance their negative climate impact or even turn them into a “climate positive” offering.” (Poseidon Foundation), and “This token will aggregate the economic strength of the LGBT community, which is estimated to be between 3%-7% of the global household wealth. The Token aims to leverages this economic power and blockchain technology to advance equal rights and full acceptance for all members of the LGBT+ community worldwide.” (LGBT Token).

Doing good is good for a business's bottom line, “Considering the market trends in the outpacing of natural products over conventional products in consumer packaged goods, and the growing market power of labels like Organic, eco, green and sustainable, we can see there is considerable consumer interest in taking our planet into account...Regen Network will open up a new economic paradigm in which markets are able to appropriately incorporate ecological health.” (Regen), “A global public and transparent Impact Marketplace would allow for easy funding, execution, trading and of impact investment products. Such an Impact Marketplace would allow impact buyers (i.e., donors, investors, payers, consumers) and sellers (i.e., impact implementers, service providers, impact-minded communities, impact driven companies/corporations, etc.) to come to a global platform, and trade events (i.e., outputs) across any sector or geography.” (Proof of Impact), and “Pioneering companies have long realized the competitive advantage of open, transparent supply chains and sustainable manufacturing. As an example, fish suppliers John West started including codes on their tuna cans to enable a consumer to trace the product back to the fisherman; this initiative alone added £17m to the brand’s sales.” (Provenance).

The discourse of economic liberalism found in about a dozen Technological Commonwealth whitepapers could be present because the authors genuinely hold a blend of economic liberal and progressive ideology. As found in all social movements, there is an ideological spectrum that participants fall from the most radical to economic liberalism, or the liberal economic discourse could be present because the authors wanted to make their projects more appealing to a mainstream audience. Follow-up interviews would be required to determine the reason why these authors included economic liberal ideological perspectives in their whitepapers.

Conclusion

This research demonstrated how whitepaper discourses are politicized, and socio-technical discursive futures are affected by sociocultural and institutional contexts. The reflexive hermeneutic approach applied in the study of distributed ledger technology projects has revealed that future-oriented sociotechnical imaginaries are not merely contrasting but rooted in deeper socio-cultural concepts of people, globality, governance, money, culture, democracy, nature, work and labor. Hype cycles and exaggerated claims in the perception of possible futures have also been affected by the general cultural belief that technology has the power to cause positive revolutionary change. The Corporate Capitalist perspective reflects the current mainstream worldview held by technologists in Silicon Valley that the existing state of the capitalist world is mainly ok, but there is a need for less regulation of business by monopoly players, big banks, and nation-states. The perspective of those in the Technological Commonwealth is a reflection of the global commons movement for a complete transformation of the political economy. They imagine building a more just, vibrant, regenerative, and equitable world. Future studies might explore how these perspectives on future change as time passes and the technology evolves.

III. Conclusion

> *Technology can deliver more than one type of technological civilization. We have not yet exhausted its democratic potential.* (Feenberg, 2010, p. 29).

The world economy is moving to the blockchain. In the World Economic Forum's survey on "Technological Tipping Points," they predict that by 2027, 10 percent of the global economy will be dependent on blockchain technology and that by 2023 nation-states will be collecting taxes via blockchains (WEF Survey Report, 2015). This economic shift is only made possible by the

community of almost 100,000 developers working on the various blockchain-based applications. The blockchain development community continues to grow to meet the demand for these technical skills, and it is predicted to grow to 2,000,000 blockchain programmers by 2020 (Arnold, 2017).

Karl Polanyi wrote in 1944 of a *great transformation* that drove the logic of markets into social life and created conditions that permitted the rise both of fascisms and social democracies (Polanyi, 1944). We are now in another period of global transformation, in which blockchain technologies are an emerging force (Tapscott & Tapscott, 2016). Over 80% of bankers expect to adopt blockchains by the year 2020 (Connolly, 2017). This transition, in turn, is expected to fundamentally reorder the governance of production, which will have widespread institutional consequences for the global economy (MacDonald et al., 2016). Yet blockchains, like other technologies, exhibit tendencies that pursue different future trajectories depending on the conditions under which they are enacted.

We need new understandings of the countervailing tendencies of blockchain technologies as well as of the contingencies that shape their deployment. The study of blockchains and cooperatives involves historical forces that possess distinct origins. Yet, as discussed in this article, there are economic sectors wherein blockchain technology is being used to further cooperative goals. Blockchain technology could enable the construction of a technological commonwealth wherein advanced exchange, communication, and decision-making technologies are used to aggregate, distribute, and govern capital at multiple levels and on a cooperative basis. The essential structure of blockchain technology grants the potential to greatly advance sustainability, efficiencies, working conditions, transparency, and democracy in the global economy. A countervailing set of tendencies portend deepening inequality and democratic decay

caused by technological stratification, the reduction of large sections of the population into disposability, the weakening of regulatory oversight, and the technologization of corporate personhood. Thus, while the primary tendency of blockchain technology is toward greater distribution, decentralization, and democratization, it may be that the most powerful applications of blockchain exacerbate inequality.

Indeed, the cooperative movement faces significant barriers under existing global capitalism. Cooperatives and entrepreneurs operating under the logics of the cooperative movement generally do not have access to large amounts of capital, nor do they control state power. Incumbents who benefit from economic inequality are better organized, resourced, and empowered, and attempting to institutionalize this notionally anarchic technology for their own ends. Blockchain technologies should provide cooperatives with some new degrees of relative advantage against both corporate capital and autocratic states. Because of the novelty of these technologies, researchers are only beginning to identify the types of questions and data needed to evaluate the multiple contingencies that shape the deployment and effects of blockchain.

There is not a straight line between technological innovation and the increasing complexity of the political economy, and as a society, we can decide to create technologies that will enrich humanity rather than commodify it. However, I believe it is a certainty that if we continue to live on a planet where capitalism is the dominant determinant of value accounting and social identity, then expanding complexity and distorted value accounting will usher humanity to the edge of the collapse of democratic civilization.

Popular sovereignty, on the other hand, may have a future. Cooperatives and democracy activists may find themselves capable of overcoming their early structural disadvantages by building a coalition of technologies and broader publics. As we have repeatedly pointed out,

much of the motivating ideology and daily practice of blockchain coders is idealistic, utopian, decentralist, and cooperative. Furthermore, many blockchain technologists became wealthy through early investments in cryptocurrencies and are thus free of the dictates of wage slavery. As the proximate constitutionalizers of the new blockchain world, technologists are in a potentially determinative position, and their affinities matter. Add in the strong desire for the kind of world society that cooperatives are programming into their blockchain applications that were articulated in the global democracy wave of 2008-2014, and we see that a rising of global popular sovereignty may not be so improbable after all.

As the case of Puerto Rico demonstrates, we need to break out of capitalist and colonial development mindsets and listen to what the people on the ground express they need. As academics, investors, and technologists, we need to be a part of creating regenerative systems of living. And resilient communities that have sovereignty through local cooperative control over all the necessities of life. This is a vision of local communities that are sovereign because they are growing their own food, producing their own renewable energy, housing, education, and medical care that is available to all. Regenerative sociotechnical solutions can only be effective if they are the expression of such sovereign communities, adapting technology to their own contextual cooperative needs.

There is an urgent need to develop innovative global commonwealth institutions to build the world over again. I believe that if techno-cooperativists are not successful in their use of blockchain technology to democratize the global economy, our future will be worsening the climate crisis, rising inequality, the spread of fascism, and further immiseration of the world's people. As blockchain technology still maintains interpretive flexibility, the next few years will be determinative as to who will win the struggle over the use of blockchain technology. As I

have written, the tendencies of blockchain technology could lead towards a more distributed and democratized commons-based economy, yet many of these same tendencies are being shaped by nation-states and corporations to close off possibilities to political opponents. Cooperatives and democracy activists such as those found in the P2P Foundation, MetaCurrency Project and Fair.coop may be able to employ successful strategies such as changing the culture, building better technology tools, and fighting for non-reformist reforms that overcome their early structural disadvantages and build a global technological commonwealth of the future.

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Appendices

Appendix 1: a list of the auto generated codes for each set.

Auto-Generated Codes for the Technological Commonwealth whitepapers
Data
Token
System
Blockchain
Energy
Market
Transaction
Network
Services
Use
Technology
Current

Value
Platform
Development
Products
Key
Local
Project
Contract
Information
Digital
Application
Public
Supply
Business
Model
Carbon
Security
Blood
Process
Power
Price
Solution
Assets
Decentralized
Chain
Community
Economic
Sots
Function
Specific
Management
Exchange
Voting
Electricity
Impact
Providers
Program
Credit
Companies
Sales
Food
Identity
Access
Trading
Generation
Payment

Central
Account
Financial
Sharing
Nodes
Smart contract
Operations
Level

Auto-Generated Codes for the Corporate Capitalist whitepapers

Transaction
Blockchain
User
System
Network
Block
Token
Data
Current
Nodes
Protocol
Key
Market
Value
Contract
Decentralized
Process
Public
Security
Function
Technology
Service
Assets
Exchange
Bitcoin
Fees
Platform
Consensus
Mechanism
Model
Applications
Time
Account
Digital
Development
Mining

Chain
Payment
Algorithm
Cryptocurrency
Address
Signature
Voting

Appendix 2: a list of *A priori* codes.

Democracy
Global
Imagination
Decentralized
Sovereignty
Capital
Commons
Cooperative
Distributed
Encryption
Future
Governance
Immutability
Maintainer
Miner
P2P
Peer-to-peer
People
Problem
Revolution
Social
Solution
Stakeholder
Trust
Value
Vision
Wealth

Appendix 3: Interview Methodology

I interviewed a wide range of professional individuals associated with distributed ledger technology projects, companies and foundations. They are high net worth elite individuals who are the founder, CEO, or executive director of technology organizations. They are public speakers at TED and blockchain conferences. They are closely networked together and I recruited participants through introductions and snowball sampling in which I give my contact information to participants to pass along to other potential participants. I also interviewed

individuals attending blockchain conferences including professors, lawyers, investors and government officials.

Interviewees where informed that I was a doctoral student at the University of California Santa Barbara in the Global Studies department gathering information for my research on distributed ledger technology.

My interviews ranged in length from 15 to 60+ minutes. Some were in person and some were conducted via video phone calls. When they were recorded it was done with the permission of the interviewee. The interviews that were shorter in length occurred at blockchain conferences. When they were not recorded, I took notes of the interviewee's answers on paper.

The topics covered during the interviews were dependent on the individual's position within the blockchain world but covered topics such as how and why they were involved with blockchain technology, what they believed were potential opportunities and dangers associated with blockchain technology, and what they thought the future held for those involved in the blockchain world.

Appendix 4: What is a HoloPort?

"The HoloPort is an easy and direct way to support the distributed Internet, designed to host peer-to-peer Holochain applications. As easy-to-use dedicated Holo hosting devices, HoloPorts serve as a bridge between the community running distributed Holochain applications and visitors from the web. Owners of HoloPorts can charge fees for their hosting service and earn HoloFuel. HoloPorts come in three sizes—the HoloPort Nano, the HoloPort, and the HoloPort+. The HoloPort is a plug and play device built for hosting Holochain apps to service mainstream web users. The HoloPort runs as a stand-alone server with a Linux distro installed, pre-configured, to run/host efficiently. A HoloPort needs Internet service, but it does not need to be connected to a computer. HoloPort can run 24/7 using very little electricity (15W-45W). It will come with a Holo host Linux image (based on a custom NixOS build) that includes a mobile/web UI to configure with your host settings. You will need to interface with the Holo admin UI to configure some settings. You can select the hApps you want to host. HoloPorts are NOT required for hosting on Holo. Anyone can be a host. In the future, you will be able to a) download the Holo Host OS image, or b) download the Holo hApp that can be installed on existing Linux/Window/Mac systems, including low-power computers such as Raspberry Pi and enterprise devices." (From Holo's website, https://holo.host/faq/what-is-a-holoport/)