

This is the author's version of a chapter accepted for publication in the *Handbook of Peer Production*. Changes resulting from the publishing process such as copy-editing, typesetting, and other quality control mechanisms may not be reflected in this document. This author manuscript version is available for personal, non-commercial and no derivative uses only.

Citation: González, P. V. & Tkacz, N. (2021). Blockchain, or, peer production without guarantees. In: M. O'Neil, C. Pentzold & S. Toupin (Eds.), *The Handbook of Peer Production* (pp. 238-253). Malden, MA: Wiley-Blackwell.

ISBN 9781119537106 Available at: <https://www.wiley.com/en-au/The+Handbook+of+Peer+Production-p-9781119537090>

The Handbook of Peer Production

Chapter 18 – Blockchain, or, Peer Production Without Guarantees

Pablo Velasco González, University of Aarhus, Denmark & Nathaniel Tkacz, University of

Warwick, UK

1. Introduction

Blockchains are aggregated and distributed databases: shared, chained, and immutable registries that conflate the production of digital tokens with their circulation. At their most basic level, they are technologies for keeping account, or records, of some form of activity, hence they are part of a long lineage of storing data, from clay tablets to bookkeeping. Perhaps their most significant quality is that they enable the distribution and storage of digital data, such as records of transactions, contracts or other statements, that are independent (or resilient) from centralized points of control. Such resilience is achieved by distributing data among a network of peers who validate the flows of information and store them as sequential blocks: the longer the chain of blocks and the bigger the network of peers, the more secure the transmission of reliable data and the more difficult it is to tamper with. On a technical level, then, blockchains are peer-to-peer (P2P) structures for distributing and storing data. But unlike most other P2P initiatives in which the network functions to share and distribute information and resources, the peers in a blockchain network have the additional function of verifying and validating the data they help distribute.

As is well known, the first implementation of a working blockchain was the Bitcoin cryptocurrency. While Bitcoin has been the subject of wild speculation, both political and financial, it was initially conceived as a way of replacing third-party intermediaries (i.e. banks and card providers). It aimed to enable the secure transmission of currency-type tokens (via a virtual wallet application), with the blockchain simultaneously verifying and recording that a transaction had occurred. By combining the ‘transaction moment’ with the ‘recording moment’ and by making this record public and irreversible, Bitcoin enabled a mode of digital exchange that could bypass the established systems of financial mediation.

During the first few years of Bitcoin's operation (beginning in 2009), Bitcoin was not thought of as an instantiation of blockchain technology; rather, the blockchain was considered a component of Bitcoin. As a digital cryptocurrency, Bitcoin is effectively software and was released under an open source software license. This enabled many early experiments, after which a consciousness of the significance of the blockchain component of Bitcoin emerged. While the early experiments were largely conceived as cryptocurrency alternatives, in time more fundamental evolutions were envisioned, such as Ethereum, which expanded the capacity of blockchains beyond the transmission of units by adding a programming layer on top of the blockchain. This additional layer made it possible to create "smart contracts," agreements in code that have the capacity to self-execute when certain conditions are met.

As an innovation in terms of value transfer (currency) and records (ledger), with additional programmability (smart contracts), the blockchain has inspired the full spectrum of financial and economic thought, from those seeking radical alternatives to global financial capitalism to those hoping to innovate and disrupt economies just enough to get rich quick, to established financial giants seeking to maintain their position by absorbing and disciplining anything that looks like competition. As the collective consciousness of blockchain increased, a whole swath of non-currency implementations were experimented with, from real estate title transfers to digital identity systems, political voting and the creation of wills.

In this chapter, we do not offer the reader a detailed technical explanation of the blockchain or focus on how a blockchain could be used within commons and peer-produced projects. Although we will provide a selected overview of specific projects and at times some technical detail, we do so within the context of an argument about blockchain and peer production. What we are interested in, broadly speaking, is what blockchain

means for peer production. How do the two relate to each other? What is the fate of commons-based peer production when it is able to produce software artifacts ostensibly in the service of creating scarcity and market conditions? What kind of peer production is this?

The chapter begins with a historical consideration of the emergence of peer production, including a reevaluation of the work of Yochai Benkler. We aim to show that peer production was given coherence as a model of production by being contrasted with two other modes (hierarchies and markets) and through the lens of Benkler's economic liberalism. Within this framing, what distinguished peer production from these other modes was that it was no longer reliant on price signals (markets) or commands (hierarchies) to organize production. While the earliest blockchain project, Bitcoin, resembled peer production in many ways (as software operating under an open source license), it also reintroduced dynamics that peer production was ostensibly thought to transcend, namely price signals and scarcity. We use this apparent contradiction to reflect on the historical legacy of peer production and blockchain, before proposing a revised approach to peer production; one, following the work of Stuart Hall, that is "without guarantees." The second half of the chapter begins this revised inquiry, focusing on the multifaceted and variegated notion of peers that is present in blockchain projects. We distinguish between four moments or aspects of blockchain initiatives that configure peers in different ways: peer-production, peer-development, peer-governance and peer-exchange. Blockchain is not just another instance of peer production, nor is it straightforwardly a tool for advancing the political project of peer production. It must be taken as an opportunity to revise and rethink what peer production was, and what it might become.

2. Coase's Benkler

Peer to Peer (P2P - a type of network) and the closely-related, 'peer production' (a type of collaboration) must be understood in their proper context, as *historical*. Not in terms of destiny or as a kernel for some possible society to come, but in the somewhat more ordinary sense of emerging at a certain time and within a certain milieu. Consider a simple Google Ngram graph (Fig 1.) featuring the terms p2p, peer to peer and peer production (not case sensitive). What is evident is that besides a rather modest rise in the occurrence of the tri-gram 'peer to peer' beginning around the 1980s, the terms 'p2p' and 'peer production' were entirely insignificant in published books in English until the late 1990s for 'p2p,' and the early 2000s for 'peer production.'

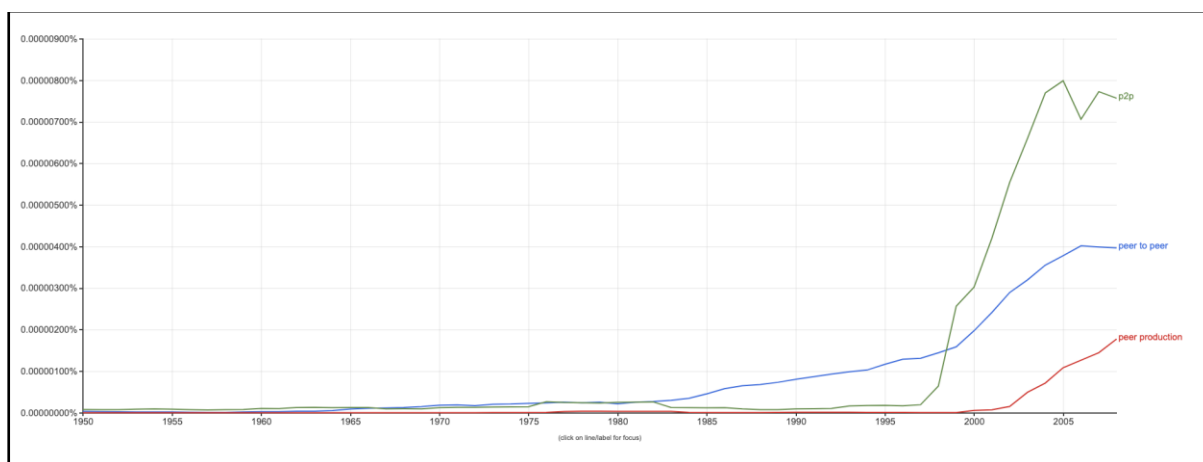


Figure 1. Google Ngram query for 'p2p,' 'peer to peer,' and 'peer production'

It would be naive and slightly inaccurate (in terms of the Ngram timeline) to suggest that the popularization of P2P – whether conceived as software, infrastructure, practice or politics – can be attributed to the advent of Napster (1999), but the significant rise of these related terms occurs within something of a *Napster milieu*; a time of technical, political and economic experimentation with network affordances. For its part, 'peer

production’ comes later still, suggesting, perhaps, its status as an *intellectual response* to the ‘90s phenomenon of ‘p2p.’

These terms are also historical in the sense that they can be located in relation to discussions around particular projects, especially software and related ‘open source’ and ‘free culture’ projects, and within wider discourses of technological enthusiasm. It was a time of cybercultural experimentation with identity, DIY Indymedia, homepages, chat rooms, and of course, file-sharing. Shortly after, blogs, Wikipedia, YouTube, ‘social networking sites,’ and other nascent platforms would mature, providing countless examples of ‘user generated content.’ The masses were newly minted as productive and peer production tried to lend political coherency to these highly diverse developments. Not a simple feat by any means.

While there were several early influential theorizations of P2P and peer production, and many, many more people involved in promoting and participating in actual peer-produced and related projects, it is difficult to imagine peer production gaining the visibility it has achieved if not for the intellectual work of Yochai Benkler. Benkler lent Ivy-league credentials to thinking seriously about what he coined as “commons-based peer production” and, significantly, he located this notion within a clearly identifiable liberal political-economic framework. His Adam Smith-invoking *Wealth of Networks* (2006) was hugely influential (currently nearing 11,000 citations), but many of the core ideas for this larger monograph can be found in earlier writing and in particular his article “Coase’s Penguin, or, Linux and The Nature of the Firm” (Benkler, 2002), where he first makes a case for the significance of peer production as an organizational model. In order to understand something of the historical dimension of peer production, in how it relates to the events of its time and how it was positioned in specific economic and informational ways, we begin with a consideration of Benkler. This weaving of peer production into a

broader context of market and non-market production is also precisely what blockchains have done in practice, some years later.

In ‘Coase’s Penguin,’ Benkler sets up an originary contrast between peer production and two other “models” or “modes of production” (2002, p. 376). To establish the contrast, Benkler draws on Ronald Coase’s classic work on firms and the theory of ‘transaction costs’ developed therein (1937). Coase was trying to understand why firms (understood as entities that supersede the price mechanism) exist, given the accepted doctrine within his field that the price mechanism was the superior method of ‘economic coordination’. He sought a rationale for the existence of firms that was largely immanent to, or compatible with this doctrine. That is, he sought a legitimate justification of the existence of firms on (liberal) economic terms. A comprehensive account is not possible or needed here, but Coase proposed that there were costs related to accessing markets (and their coordinating signals) and that in certain circumstances the organization of production can be more efficient if it bypasses or internalizes these signal-exchange relations. As Benkler puts it, “using the price system is costly” (2002, p. 401). Coase’s work was further developed by a number of organization theorists (who Benkler also relies on), culminating in a condensed theory of production reducible to two main forms: hierarchies and markets. The key *economic* distinction between them is given in terms of information signals and coordination: hierarchies organize production through *managerial commands*, while markets coordinate production through *price signals*.

While Coase sought to understand firms, he did so from within the market orthodoxy, building explicitly on the (neo-classical) work of Smith, the (neo-liberal) work of Hayek and others, and never challenging the market paradigm fundamentally. His work can be seen as something of a paradigm-native minor corrective, whereby the existence of firms is explained by their capacity to out-coordinate markets in terms of efficiency.

Benkler's peer production follows this Coasian trajectory, but instead of just markets, it now contends with market and firms, or markets and hierarchies and their respective signals (managerial commands and price). It is an account of production that presents markets as the default (superior) form. Correspondingly, the main criterion through which to assess a particular form (mode/model) is its capacity to organize or coordinate economic activity through signals and indeed, this is precisely how Benkler understands the unique contribution of peer production.

When peer production is referred to as a 'third mode' of production by Benkler and others (Bauwens, 2005; Bauwens, Kostakis, & Pazaitis, 2017; Benkler, 2002, 2006), it must be understood within this Coasian trajectory. Benkler extracted from the political-economic richness and diversity of (FOSS) software development and early web cultures, a specific argument about economic coordination and efficiency within the tradition of Coase: "Peer production emerges, as firms do in Coase's analysis, because it can have lower information opportunity costs under certain technological/economic conditions" (2002, p. 375). And while acknowledging the other important "normative implications" at stake in peer production regarding "freedom and equality", Benkler clearly avoids suggesting that peer production has arrived to replace the other two modes:

I am not suggesting that peer production will supplant markets or firms. I am not suggesting that it is always the more efficient model of production for information and culture. What I am saying is that this emerging third model is (a) distinct from the other two, and (b) has certain systematic advantages over the other two in identifying and allocating human capital/creativity. (2002, pp. 381–382)

The "systematic advantage" is described in terms of "information gains": the "capacity to collect and process information about human capital" (2002, p. 412).

Whether or not peer production did or does have any kind of systematic advantage over other models is beside the point. By the time one arrives at these technical

considerations we are well and truly down the Smith-Hayek-Coase-ian rabbit hole, where peer production is positioned in relation to markets (understood as information processors, ideal forms of economic coordination, and sites of freedom) and firms (which complement markets through internalizing transactions to improve efficiency) and compared in these terms of economic coordination and efficiency. There are empirical and theoretical problems with this orthodoxy (Beckert & Aspers, 2011; Beverungen, Mirowski, Nik-Khah, & Schröter, 2019; Çalışkan, 2010; Ghoshal & Moran, 1996; Mirowski, 2015) and further issues with approaching instances of peer production from within this frame (Terranova, 2009; Tkacz, 2015), although most of these need not concern us. Instead, and to introduce yet another sense in which peer production is *historical* (this time via historical comparison), we turn to the ostensible focus of this Handbook entry, blockchains.

3. Coordination Issues

While the perceived potential for blockchain-based initiatives stretches as far as the entrepreneurial imagination, in terms of actual implementations the blockchain space is still dominated by cryptocurrencies, with Bitcoin being the oldest, largest and most valuable. Acknowledging that there is significant variance among existing blockchains, Bitcoin and related cryptocurrencies introduce new dynamics into the peer production space directly relating to these Coasian questions of transaction costs and production models. We will use Bitcoin as our discussion point below (as one blockchain implementation), before launching into a more expansive consideration of blockchain projects.

If peer production is understood as a third mode of production, how can we understand Bitcoin and blockchain in relation to this mode? The most obvious starting point is at the level of software. Bitcoin and by extension blockchain are open source, with

the Bitcoin Core software operating under the MIT License (“MIT License,” 2019). In this regard, Bitcoin can be added to the long list of software projects held up as models for peer production. As open source software, it also means that Bitcoin and some other blockchain projects may resemble the development, governance and organizational dynamics of other open source projects. Beyond this, though, the relationship gets murky, problematic even.

While we have never idealized peer production, nor submitted to the idea that there are only two or three ways of organizing production (markets, hierarchies, and peers), some cryptocurrencies (including Bitcoin) and blockchains do resemble other peer production projects in the way they are made. That is, as software, they look like other open source software. But, whether considered money- or currency-like, or as financial assets, exchange infrastructures or distributed accounting systems, blockchains and cryptocurrencies *turn away* from the conditions from which they came into being. That is, they are produced as or within a commons, but turn away from these commons to face (and indeed facilitate) its others. Recall that for Benkler price signals are an artifact of markets and have a cost attached to them. Peer production is precisely that which doesn’t rely on price signals; it coordinates production without such signals. So why the push to recreate market signals and/or related systems of accounting?¹

There are two possible answers: one that takes us further down the rabbit hole (of economic efficiency) while the other rests on historical contingency and political action.

1 While we haven’t highlighted questions of property thus far, Benkler also attributes part of the superior efficiency of peer production to its being outside typical property relations, resulting in what he calls “allocation gains”: “Peer production relies on making an unbounded set of resources available to an unbounded set of agents, who can apply themselves towards an unbounded set of projects and outcomes” (2002, p. 415). While we are focusing on Bitcoin, currency and signals here, the non-property dimension of peer production equally raises questions about the accounting dimension of blockchain. Just as we may ask why peer produced artefacts should seek to recreate price signals, we may equally ask why they seek to produce systems of accounts which throughout history have overwhelmingly been used to keep track of property. There are, of course, other uses of ledgers and other uses of accounting. Further exploring what these may be and what potentials they may unleash with regards to blockchain is an intriguing avenue of experimentation, though beyond what we can explore in depth here.

There is an element of truth to both answers, and together they push us to rethink some core elements of peer production. Answer one: While markets are generally the most efficient way to coordinate economic activity, markets themselves must be organized. Such organization is also costly and is typically handled by state and state-regulated actors (i.e. ‘hierarchies’). Bitcoin and other cryptocurrencies could reduce the costs of facilitating market activity by replacing hierarchical facilitation with peer facilitation. In this argument, the emergence of Bitcoin and blockchains can be explained by the possible inefficiencies of the hierarchical facilitation of markets. Satoshi Nakamoto’s early white paper explaining Bitcoin can certainly be read this way (2008). In the title of the white paper, for example, Bitcoin is described as a “Peer-to-Peer Electronic Cash System” – an initial positioning move. The first sentence of the white paper’s abstract reads: “A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution” (Nakamoto, 2008, p. 1). ‘Financial institutions’ are presented as an unfortunate but heretofore necessary cost of market activity, especially digital activity where cash is not used. In the opening lines of the introduction, Nakamoto directly locates financial institutions in relation to transaction costs, describing them as third-party intermediaries whereby “[t]he cost of mediation increases transaction costs” (2008, p. 1) and further elaborates that such mediation limits the “minimum practical transaction size” (i.e. micro transactions) and also relies on a system of trust to work (because the time-space of the transaction between parties is not identical to that of the accounts (ledger) where the transaction is recorded).

Libertarians have heralded Bitcoin’s claim to disintermediate financial institutions as a kind of market victory over hierarchies; however the white paper makes no reference to this and does not mount a political attack on banks in these terms. Rather, banks are undesirable because they add to transaction costs – even the discussion of ‘trust’ is framed

in terms of efficiency.

The rest of the white paper offers a technical description for how Bitcoin works, beginning with a section on transactions. Understood in this way - as part of the Coasian universe of transactions – it's difficult to see Bitcoin as advancing the model of *peer production* in any but the most limited of ways. Instead, it aims to improve the efficiency of *markets* to produce signals by reducing market-based transactions costs. As is well-documented, Bitcoin has not made serious inroads as a currency or money-like entity; it has not been able to produce more efficient price signals and it has by no means spelled the end of financial institutions. However, just because Bitcoin has thus far failed to disintermediate financial institutions does not mean it is not useful to understand it in relation to such aims and actors. As we shall see, blockchains are indeed Coasian technologies; they embody a vision of transactional efficiency that drives experimentation, just not in the way described in the white paper: as disintermediators of financial institutions.

The second answer to the question (of recreating market signals and/or related systems of accounting) lies in relation to the historical event of the 2008 global financial crisis. The publication of Nakamoto's white paper came roughly a month after the collapse of the Lehman Brothers investment bank in September 2008. The significance of this event cannot be underestimated in providing the conditions for Bitcoin and other cryptocurrency experiments to flourish. In a recent interview commenting on this relationship, historian of digital culture Finn Brunton makes a similar observation:

[Bitcoin] had a really specific genesis, which was introduced and adopted as the world went through an absolute financial catastrophe. We forget how terrifying it was when it looked like we were on the verge of a planet-wide credit freeze, with all of these organizations in free fall and when the tremendous brittleness of the financial infrastructure was all coming due, one piece after another. (Brunton, cited in DuPont, 2019)

The global financial crisis laid many things bare about finance and economy to a generation of non-specialists for the first time: the madness of some financial assets (such as the ‘collateralized debt obligations’ that made their way into popular culture through films such as *The Big Short*); the reality of (housing) bubbles; the interconnectedness of finance companies; the power of governments to intervene via ‘bail outs’; the interconnectedness of global financial markets (such that the ‘US’ crisis quickly spread); and, the strategic use of such events to make ruthless government spending and investments cut across many aspects of society (austerity). Through witnessing the crisis unfold, it was possible to see how ‘everything was connected’ in a dark, almost fatalistic way, from an individual housing loan to the viability of large firms and, indeed, the very sovereignty of nations (e.g. Greece). Adding to this connectedness, the financial system seemed arbitrary, highly fragile, and most importantly, a site of power. From this perspective, the rise of Bitcoin (and eventually other blockchains) had less to do with the efficiency of transaction costs, and everything to do with timing. As we have documented previously along with others, Bitcoin is by no means the first attempt to create a digital currency that short-circuits incumbent financial and state actors (De Jong, Tkacz, & Velasco González, 2015; Maurer, 2005).

And while writers such as David Golumbia (2016) are correct in their assessment that a certain right-wing extremism surrounded Bitcoin (and arguably is inscribed in the code), so that a dark current ran through the project from its inception, it’s equally true that in the fallout of the crisis many people from a diversity of political leanings saw in Bitcoin an alternative possibility for economic organization. Indeed, we ourselves encountered European anarcho-hackers, Autonomist Marxists, disillusioned bankers, peer producers and people with no obvious allegiances, alongside the more predictable libertarian and

crypto-libertarians in the early days of Bitcoin experimentation (see Lovink, Tkacz, & De Vries, 2015). It may well be that most people were naive to see in Bitcoin a potential that was other than what was actualized, but the point is Bitcoin was there as a vessel to absorb different visions at a time when the global financial status quo was in tatters.

Of these two possible explanations for the rise of Bitcoin (and later blockchains), the second holds more explanatory power. Indeed, despite being positioned as a technically superior infrastructure for handling transactions – that is, as a technology of market signals – Bitcoin and other cryptocurrencies and blockchains have never managed to operate well in a signal-generating capacity. However, despite Bitcoin (and other blockchains) not living up to their transactional pretensions, the specificity of this ‘peer-to-peer’ cash system is not insignificant. Bitcoin’s claim to be able to disintermediate existing financial institutions clearly mattered, as did the ‘irreversibility’ of transactions and the hard-coded limit of possible coins in circulation. These specific qualities spoke directly to the crisis: the corruption of banks; state interventions (bailouts and quantitative easing), and so on. Finally, the technical tone of Nakamoto’s paper presented Bitcoin as not overtly political (though one needn’t dig too deep to find it). When pensions are evaporating and banks are freezing and limiting withdrawals, a technology doesn’t have to do much to appeal.

4. Peer Production After Bitcoin

So far we have dwelled on the early account of peer production as a ‘third mode’ of production, centering on the proposal that it enables forms of economic coordination more efficient than market signals or managerial commands. As theorized by Benkler and others, it was an attempt to lend political coherency to a diversity of projects, happenings and technologies, and to place these within a liberal economic paradigm. The collaborative dynamics of peer production arose precisely in distinction to signals and commands (and

the property and labor relations that underpin them).

While produced as an open source and hence commons-like artifact, the arrival of the first blockchain, Bitcoin, is seemingly at odds with how Benkler first describes the (potential) superiority of commons-based peer production in that it ostensibly attempts to reintroduces dynamics (signals) that peer production was supposed to transcend. It's as if humans were set free and then went about making new chains. We offered two ways to makes sense of this, the first of which is that this 'third mode' was never designed to supersede but rather complement the others. This appears to be Benkler's position. The second way to make sense of this signal-producing effect of peer production is that it seemed like an attractive alternative at a time when the financial status quo was in an especially bad state. That is, the contradictions inherent in Bitcoin were overlooked for pragmatic reasons.

In both cases, what seems pertinent is that peer production offers no clear guarantees in terms of a pathway out of market societies (or authoritarian 'command' driven ones). It can be made to fit very well within existing liberal economic ideals (Benkler), and actual instances of peer production can easily be deployed to produce their others. that is, peer technologies can become market technologies. Suffice to say, we do not see in peer production any kind of historical destiny; no kernel for a new society. At worst, there's a potential that it actively contributes to the intensification of market relations via automating elements of bureaucracy and governance; a new kind of protocological neoliberalism.

What we have also suggested thus far, however, is that there is a counter-narrative that runs through peer production and blockchain where both are positioned as historical actors. Peer production gave a name to a cluster of energies that emerged in relation to the web cultures of the late 90s and early 2000s, while Bitcoin emerged in times of economic

crisis. Along these lines, the significant contradictions and political-economic divergences between them perhaps matter less, although are not easily resolved.

Despite the critical trajectory of this chapter thus far, our critique is not absolute. We are in urgent need of experimenting with different economic models, different relations to production (if that is the term) and different ways of being with each other and the planet. What we think is needed, and what we will begin to articulate in the second half of this contribution, is a critical reflection on existing practices (especially experimental ones) in relation to the terms given to describe them. From this vantage point, the limits and potentials of an emerging political vocabulary can take shape. The fact that we proceed with caution recalls Stuart Hall's position on Marxism some decades back. Hall acknowledged that many aspects of Marxism had been thoroughly 'deconstructed' and that the grand narrative of the destiny of the proletariat was not at all given. His Marxism, he declared, was to proceed 'without guarantees'. This was by no means a dismissal. Rather, if Marxism was to remain relevant it had to be nimble, reinvented around the changing conditions of production. Moreover, he thought many of Marx's ideas still resonated, still got at something, even if they were presented in ways that seemed crude over a century later. This informs our own approach to peer production.

In what follows, we turn to the notion of the 'peer' in peer production. The peer is an intriguing figure in a number of ways. It stands in contrast to roles in markets (exchangers, entrepreneurs, debtors, creditors, etc.) and in hierarchies (managers and employees, or 'masters' and 'servants' in Coase's language). It suggests a notion of equality, with a residual potential for group authority (peer pressure). Among the spaces of blockchain, what exactly constitutes a peer or a 'peer relation' is not always clear or immediately discernible. The peer of the blockchain is a complicated and multifaceted figure, politically and even ontologically ambiguous. It is manifested in quite different

ways across different aspects or moments of a blockchain implementation. We now pursue our ‘peer production without guarantees’ by reviewing a number of blockchain experiments with the impetus of drawing out the different facets of the peer. We break our analysis into four moments or elements common to all the projects observed (production, development, governance, exchange) and use these to reflect on what it is to be a peer after Bitcoin.

5. Peer Production

A vast sea of blockchain implementations share the common promise of distributed *production*, but not many delve into how this is enacted beyond the lure of signing up for an innovative service. Take for example the ArtID platform (“ArtID Marketplace,” n.d.), a service to certify works of art by inscribing information into the Ethereum blockchain and providing its own token (“artid”) based on an Ethereum standard (Ecr20).² Looking beyond the practical elements of such a system as a different kind of registry, what is significant is the practical absence of user participation within its architecture. Here, the role of the *peers* is equivocal: the platform makes use of Ethereum-derived tokens but only offers these as a service, thus, participants involved in these interactions function straightforwardly as clients, not as producers or active participants of the Ethereum platform. This calls into question what exactly it means to be a peer in terms of production within this architecture.

The peer-producer in blockchains can be understood either as someone benefiting from a network made of peers (such as the ArtID user, benefiting from the Ethereum

² This chapter examines different projects, but pays particular attention to the Bitcoin and Ethereum blockchain. As suggested before, despite its shortcomings Bitcoin is the first and still the biggest blockchain by market capitalization, and is especially useful for historical and evolutionary observation of the technology. Ethereum also populates a great part of the state-of-the-art projects. From the 2019 DApps (Decentralized Applications) listed by <https://www.stateofthedapps.com/> website, more than 85% (1898) are based on Ethereum. Also, it must be noted that not all DApps in this landscape share the same degree of activity, as less than 20% show a recent active development.

network), as a participant within a network of peers (enacting a peer-production organizational model), or as an actual producer of items within the organization (in the case of blockchains, a token producer). These three modes are commonly used without distinction, in some cases because they overlap, as this section will show in the case of blockchain “miners”, but also because of the ambiguity that comes with the term. Thus, this section looks for a clarification of the blockchain “peer-producer” in relation to its practices, and in particular to the third mode: the producer of tokens.

For the most part, blockchain technology folds two traditional activities of production into one: the process of “mining” is at the same time the distributed strategy for validation of all exchanges taking place through it, and the production of economic units (the “minting” of tokens). The bureaucracies of managerial command and monetization are merged into a strategy to secure highly distributed networks that claim to eschew central command.

This is also the most common scenario for participants to have the possibility of generating capital in the form of tokens with exchange value. While blockchain implementations offer a diversity of schemes regarding capital distribution and access, this is rarely an element that is meant to be available as a common (some cases where this is attempted are mentioned later). All public blockchains use “mining” as a way to produce new assets. In the case of blockchains designed to act as cryptocurrency (e.g. Bitcoin, Litecoin, Dogecoin) this enables a constant influx of exchange-tokens, which are regulated by case-by-case rules. Bitcoin, for example, regulates its supply to guarantee a production of 12.5 tokens approximately every 10 minutes.³ By design, only 21 million bitcoins will be produced (or *mined*) by the year 2024. Cryptocurrency-oriented blockchains have

³The amount produced is adjusted approximately every four years: starting with 50 in 2009, 25 in 2012, 12.5 in 2016, and 6.25 in 2021.

different reasons to control production, which more or less resonate with their goals: distributed storage, smart-contracts (triggered-execution software), registries, etc., tune different logics of production. However, all blockchains use tokens to execute transactions, and all public blockchains need to use some sort of mining procedure, not only to produce, but also validate transactions. Production in this sense, is framed by the techniques required for token generation, and peer production is enabled (and limited) by the possibility of participating in this manufacturing process.

In the blockchain, the labor to generate numbers, validate transactions, append new blocks to the chain and introduce tokens into circulation is almost fully automated. Miners are machines that verify the signed public keys for each transaction and which validate these into blocks in a public registry (i.e. the blockchain). The job for successfully validating and packing the transactions produces new tokens for the miner, and generates a Proof-of-Work (PoW).⁴ The former is the result of a ‘puzzle,’ which can be then easily checked by any other machine in the network. Since the design of the system seeks a controlled pace, if the tokens are generated too fast (because there are more and/or stronger miners) the ‘puzzle’ becomes harder (Nakamoto, 2008). The design of the system relies on a form of superabundance (Velasco, 2016) performed by computation, i.e. the puzzle performs an enormous amount of operations in order to work, which serve no other purpose than ensure to security, and consumes copious amounts of energy while producing fast cycles of hardware waste. The human part of the miner assemblage is free to modify some variables of this process, but has to ultimately adapt to the rules of the protocol.

⁴ Due to PoW high energy consumption, other blockchain algorithms have been proposed. The most popular as yet is Proof-of-Stake (PoS). In this proof model, all the token supply is usually created from scratch, and then distributed to the shareholders by network managers, thus threatening the maintenance of a decentralized model. However, these alternative algorithms have been less tested and rarely in use by big blockchains. Peercoin, for example, uses a hybrid model, relying on PoW for generation and distribution of new tokens, and on PoS for security and governance. Ethereum discarded the use of PoS due to security reasons, but is still interested in adopting an improved version in a similar hybrid way, in the near future.

Bitcoin PoW in this case is a non-human, mechanical kind of labor – “algorithm-made” (Coeckelbergh, 2015) – that produces new tokens. Aside from programming and setting up the machines, barely any human labor is involved in the process. Both programming and setting up the machines are by no means small tasks, and they depend on an assemblage of a huge number of names, discussions, infrastructure, discourses, electricity, investment, and so on. This *programmability*, however, imbues the organization of production with a specific quality: in particular one seeking to flatten hierarchies between producers (of tokens), and to delegate its operation to the network (O’Dwyer, 2014). While the latter is certainly effectively performed in most systems, new hierarchies are also generated even when considering this reduced and technically bounded version of a peer-producer.

Lana Swartz and Kevin Driscoll (2017) explored the *peerness* of Bitcoin mining by setting up a miner and narrating the difficulty to run it in an amateur setting in 2013. In theory, this only required a computer and a continuous stream of electricity and internet. Their so-called Lonely Old Bitcoin Miner (LOBM) was an anthropomorphization of a machine whose purpose was to exploit the generation of tokens, a “mechanical tin bank.” However, the experiment rapidly showed that a one miner operation required a more advanced piece of technology: by 2013 most people invested in mining jumped from powerful GPUs to ASICs (Application Specific Integrated Circuit), dedicated circuits designed uniquely to mine blockchain tokens (Taylor, 2013). This “digital mutualism” – an idealized vision of voluntary peers engaged in the construction of a common that benefits all parties involved (Swartz & Driscoll, 2017) – required a growing investment of time and resources. Since then, mining has become an industrial operation, not only in terms of specialization, but because of the impossibility of running an “artisanal” miner, i.e. a one-machine operation such as the LOBM. Contemporary mining operations run in pools: groups of miners who cooperate to solve puzzles and share earned tokens. This re-

centralizes production, as pools are most commonly controlled by one entity, thus undermining one of the main perceived affordances of the technology. However, pools are a good example of collaborative production within these ecosystems, even if here “peer” and “commons” are framed by a very specific profit-driven cooperation.

These for-profit elements raise an obvious dilemma for a commons political economy of cryptocurrencies, but it also applies to other blockchains insofar as the fundamental technological characteristic is distribution through tokens. Pools signal a failure in the original peer (technical) symmetry envisioned by Bitcoin, since mining operations are centralized by the mining pool owner, who manages operations: collaboration is less of a choice and more a necessity to keep production profitable, at the cost of losing the initial symmetry of the peers. Even if we limit our view to the more constrained conceptualization of peer-production -the miner as token-producer, where the technical affordances of a distributed network allow in theory for a flat hierarchy between the peers- the token generative design is geared towards a managerial organizational model. The figure of the miner is to be expected to leverage production without relying on price or command signals. However, the nature of a token-driven design shows how easily miner pools are reconfigured into hierarchies through the directive of price signals: profitability (or the lack thereof) demands independent miners to collaborate under a managerial system.

This does not undermine other types of collaboration within the frames of peer production, such as the development of the system itself (as shown in the next section), nor mixed alternatives for common governance (as the last section will show), but it positions the limitations that come with a design based on tokens and its permeability to the organizational models of hierarchies and markets.

This collaborative production within asymmetrical peerness also raises the question

of how this kind of cooperation would have been different if the goal had been other kind of collective objectives, instead of the *lonely* individual's own advantage (Gianelli & Fumagalli, 2013). The LOBM ultimately shows that the definition of peer within blockchains is not only a problem of policy or governance, but also a problem of technology design and the objectives embodied in it.

6. Peer Development

The conversation regarding the public status of blockchains has been more evident in relation to their development and governance. Both forms of participation provide an opportunity for shareholders to guide the architecture, form, goals, and rules of a system. Either by actively participating in the design of the software, or offering effective input on decision-making, their capacity as peers is first of all dependent on a matter of accessibility: public blockchains would allow an allegedly unrestricted participation, in a similar fashion as other traditional open-development projects. On the other hand, in private, “permissioned,” or “incorporated” blockchain access is restricted by network administrators⁵. However, unlike other open software projects, public blockchain development is disturbed by its token-based value design. This locates blockchains in a complicated *milieu* that is neither publicly (as state owned) or privately owned (as a company), nor explicitly for profit, but simultaneously reliant on a common structure and a market-dependent token economy. Many blockchain projects are based on open models of software production. As mentioned previously, models for open development have a history of commons-like collaboration, where code is a common resource built on the basis of volunteer work. Git⁶ repositories are a perfect example of a common-like system that

⁵ A third type, Consortium Blockchains, can be defined as permissioned blockchains whose management is shared between multiple organizations.

⁶ Git is a distributed version-control system, designed for collaborative development and tracking changes in

works on the premise that “everyone can use it.” Usually working as a meritocratic system, balanced by market signals, changes in open software are free for anyone to propose, as long as these changes are justified, feasible to implement, and validated by a broad community through some agreed-upon protocol. This was and continues to be the case for Bitcoin and Ethereum. Like many open projects, collaboration issues in Bitcoin can be settled via Git-like protocols, but due to its delicate consensus requirement Bitcoin development also adds a second layer of conventions for new suggestions. Bitcoin Improvement Proposal (BIP) followed the tradition of Internet Engineering Task Force’s (“The Tao of the IETF,” 2012) open calls for improvement. BIPs are essential for changes that are particularly controversial or that introduce changes to core rules of the protocol. A similar process by the name of Ethereum Improvement Proposals (EIP) is followed for Ethereum development.

Open development is an excellent example of peer production in action, as it not only shows the active collaboration in the construction of a common, but also the complex negotiation among peers involved in such tasks. One of the main advantages of working with digital elements (or Bauwens’ “immaterial goods”) is that, unlike physical goods, they are not constrained by scarcity. The possibility to multiply projects (along with what these projects have produced) is a common practice known as forking. This practice is usually limited to open projects because it involves a direct duplication, and thus no object subject to copyright can be formally forked (Tkacz, 2011). Since the initial state of the fork includes two projects with the same code, followed by changes in each branch, competition between them is considered a natural part of forking (Raymond, 2008; Weber, 2004). Similar projects to Bitcoin and Ethereum have been generated and ramified from their original source code to produce competing blockchains. Litecoin, for example, the second code.

largest cryptocurrency for a long time by market capitalization, and fifth at the time of this writing, is an example of a competing coin. It behaves as a currency, but uses a different hashing algorithm (scrypt, instead of SHA-256). It also modifies some of the Bitcoin variables, like having a faster block processing and a maximum of 84 million tokens. Litecoin has its own code branch, name and blockchain, which distinguishes it from the Bitcoin chain. It does share, however, the financial asset orientation. Thus, it can be considered a competitor within the cryptocurrencies market but, it remains an independent chain and coexists with Bitcoin and other altcoins.

A few other projects do not even enter in direct competition with Bitcoin because they use tokens merely as mediums for other ends (e.g. distributed DNS servers). Like the competing coins, these blockchain instantiations keep basic characteristics of any blockchain—a shared registry that conflates token circulation and production—but are not identified as currencies or economic elements. Thus, they are neither competing chains nor competing coins. Ethereum (“Ethereum Project,” n.d.) is perhaps the most known example; it enhanced the original scope of mere circulation by introducing a programmable and executable aspect to the blockchain. Commonly known as digital contracts, these are arrangements and rules defined between two or more parties and deployed in Ethereum’s blockchain. Because “ether” function as tokens to enable smart contracts, they are seen more as “activation” tokens than as currency. However, ether does have a monetary value and, like Bitcoin, is bought and sold in relation to fiat markets. Since all blockchain tokens share these exchange qualities (regardless if they have the intention of being a currency), they are embedded with transactional value. Due to this, unlike other digital goods, value cannot be split between two forks. Thus, the outcome of the fork represents not only the future of the project, an ideology for or against centralization, the endurance of a group of people, or the restructuring of governance rules, but also a substantial economic interest.

7. Peer Governance

Production and ownership of tokens also correlates directly in some projects that have integrated governance into their technical workings. That is, decision-making is not only being performed through traditional external channels (e.g. forums) but integrated into the infrastructure procedurality. Primavera de Filippi (2015) defines ‘governance by design,’ as “the process of online communities increasingly relying on technology in order to organize themselves through novel governance models (designed *by* the community and *for* the community), whose rules are embedded directly into the underlying technology of the platforms they use to operate.” This marks an interesting distinction between blockchain projects that not only use governance processes *of* their infrastructure, but also *by* their own infrastructure (De Filippi & Loveluck, 2016). In the former case, to apply changes to the protocols, rules, and general orientation of the project open source community regulations, like BIP or EIP, are followed.

In this case, expressing arguments, especially when made by a known or respected part of the community, can leverage disagreements. In borderline situations, issues may be settled by a distinctive figure of authority; in the case of the Bitcoin community, for example, the opinion of Gavin Andresen, one of its main developers until 2016, was highly respected and generally accepted as a rational and sometimes definitive voice to settle controversies. In the latter, “governance by infrastructure,” a technical consensus must occur to reach agreements. This means, for example, that a majority of computers within the network must implement the proposed changes, by running specific code, in order to successfully adopt them as a standard. The governing rules for this first kind of consensus are embedded directly in the protocol and take into account all the ‘votes.’ Some alternatives to the PoW proof algorithm function explicitly as a claim to democratic

participation in the governance process. The delegated proof-of-stake (DPoS) matches tokens with decision shares. DPoS, delegated proof-of-stake, gives the shareholders with the majority of shares a major stake in participation in “governance by infrastructure”. This is an on-chain governance model, which means that governance is directly integrated in the technical system. Current projects, like Tezos, have made this on-chain capacity their distinctive feature, as a strategy to relocate power dynamics from developers and miners towards shareholders. Both PoS and DPoS carry the risk of monopolies controlling a supposedly distributed system, and even the best on-chain design is vulnerable to meddling by off-chain private interests (Reijers et al., 2018; Schaffers, 2018). However, different projects experiment with tweaks on their protocols to avoid extreme control by accumulation. Peercoin, for example, makes it costly to produce new tokens by PoS, in order to avoid monopolies. Coordination, however, is again dependent on token ownership, thus emphasizing the importance of exchange-value within most blockchain systems.

The affordances for peer-governance are not limited to the modification protocols. Some projects use these novel participation possibilities to experiment with democracy and contemporary social issues. An interesting example of this is Civil, a blockchain-based platform for news curation, aimed at confronting the current disinformation crisis of mainstream media and centralized platforms. It has been proposed as a strategy to fund independent journalism as well as technique to foster high quality and trusted content production. Formed as an alliance of “newsrooms,” the platform is in principle open to everyone, but users must go through an application process to be part of the Civil Registry. The peer in this ecosystem is defined by its adherence to a set of in-progress journalistic ethics (Iles, 2018). Like other blockchain-based projects, Civil aims to remove intermediaries -traditional media institutions, but also platforms such as Facebook and Google- and provide a direct channel between journalists and their readers. The project is

described as “community owned” because token ownership acts as a share on the platform, and as a mean for voting and for challenging dubious newsrooms. A civil council formed by independent journalists may overrule a community vote, but if a big percentage of the community agrees on a vote, council decisions are overruled, thus enacting peer governance in a similar fashion as the aforementioned Peercoin. Civil describes itself as a “decentralized marketplace,” but recognizes that the use of economic incentives does not imply rational choices, and that understanding the motivation of a community is an ongoing process (Vuong, 2018).

Thus, the Civil project is an attempt to exploit distributed ledger technology as a new option for a content market, while recognizing the problematic of a purely market-driven strategy, therefore the stress on the constitutional grounds. Still a work in progress, Civil offers a promising experiment for token-driven content generation for post-truth journalism. And while it has been confronted with the challenges of a novel token-driven economy -failing to reach their 2018 ICO goals, for example- it is a project that uses blockchain technology to experiment for a much-needed sustainable model of online newscasting.

While improved governance is possible outside the mint production, this is not a characteristic that comes with blockchain technology. A distributed infrastructure may be a uniquely useful tool for any attempt to develop the commons, but blockchain is not a groundbreaking technology designed for this goal, and certainly not an inherently collaborative system. What is more, on-chain coordination, is pegged with token exchange-value, which, as we argue is an inherently designed quality of these systems. This clarification is crucial to discuss the limits and affordances of implementing blockchain technology alongside commons-oriented projects.

8. Peer Exchange

It has been argued that the blockchain presents a paradox of social and anti-social qualities (Alqassem, Rahwan, & Svetinovic, 2018). On the one hand it facilitates transactions (and interactions, if we consider the Ethereum blockchain), by virtue of its lack of mediators. On the other hand, part of the community involved in its design concurs with a strong pursuit of privacy and anonymity. The first part of this paradox, the idea that blockchains are “social” due to their transactional resourcefulness, is based on the misled yet common amalgamation of peers as producers and peers as exchangers. Being able to make transactions over a distributed ledger system does not imply the participant is involved with production, and even the peer-producers (by means of mint or governance) do not necessarily produce use-value for a community. The exchange use of the blockchain is straightforward, and participation as a peer in this sense is frequent in all projects, due to their token-exchange reliance. However, the discussion regarding participation of peers as producers of communal use-value is significantly more nuanced: some blockchain-based projects consider co-production for specific communities, while others focus on enabling speculative wealth for individuals.

Unlike some of the public blockchains discussed earlier, there is a growing type of private projects that make use of distributed ledgers, but limit production and validation to a selective set of shareholders, while allowing exchange to a broader public. A majority of the investment currently relies on these “incorporative” (Swartz, 2017) blockchain projects. An example is the *Nasdaq Private Market*, a blockchain implementation to manage private shares of technology companies pre-IPO’s, or the *Hyperledger*, an open blockchain development project backed by a long list of big institutions and corporations (IBM, the Linux Foundation, Cisco, Intel, JP Morgan, and Wells Fargo, to name only a few), which works to develop a secure blockchain framework for regulated industries. A

majority of banks are also developing incorporative blockchains to adapt them to the current economic model. The goal of these kind of projects is “not to disintermediate the financial system, but to determine how to be better intermediaries” (Swartz, 2017, p. 19). Like other private blockchains, the shareholders of the system are limited and deliberately selected. The system design of a distributed ledger remains and some degree of compatibility to other systems remains, but the centralization and ownership differs on each blockchain.

Incorporative blockchains are not the only example of limiting a set of users to exchange-value operations. A recent case to enable exchange-peers for welfare took place with Syrian refugees in Jordan. This was supported by the UN’s World Food Programme (WFP), and implemented by Parity Technologies, led by Ethereum founder Gavin Wood, and Daterella, a big data and blockchain startup. The WFP project was used to record and authenticate food vouchers given to refugees on the Ethereum blockchain (UN City Copenhagen, 2017). The affordances of using a distributed ledger diminished the costs and risks of using cash or other payment means in areas without a financial infrastructure. The use of this technology also allows for fast reactions, low costs, and manageable implementation, which makes it ideal for emergency situations, unstable geographies, and scarcity of infrastructures. In this context, the use of blockchain technology proved to be useful and this project could most probably be replicated, improved, and enhanced in future iterations. There is an evident advantage in the use of the Ethereum blockchain in this case regarding exchange value: it is an expedite and functional implementation that imbues the users as peer-exchangers. It would be risky, however, to describe all participants in the project as peers participating in a common. The goal of the WFP project in Jordan was aimed primarily at enhancing control, as the system’s transparency is tied with its monitoring readiness: the way the funds are used by refugee families is tracked and

limited to allowed purchases (such as olive oil, or lentils). The refugees involved in this project had as much participation as any user of a voucher has with the banks behind it. The blockchain in this case serves the production and tracking of the vouchers, but only involves the refugees as endpoints.

A comprehensive role of stakeholders in regards to production, governance, and exchange is rendered more successfully in novel distributed social networks. *Steemit*, a blockchain-based network launched in 2016, offers a blog-like content platform. Pitched as a decentralized and censorship-resistant platform for content generation, the project intends to stimulate user's production of posts by monetizing them. The broad description "Get paid for good content. Post and upvote articles on Steemit to get your share of the daily rewards pool" ("Steemit," n.d.) summarizes its hybrid economy model. Users can receive micropayments either for producing materials, or for upvoting (similar to Reddit) new "undiscovered" content. The platform has three value forms: STEEM, Steem Power, and Steem Dollars, which pay the role of a cryptocurrency token, a voting token, and a stable-value token. STEEM is a liquid asset, that can be converted into other currencies. It acts as a flexible currency with a clearly identified use-value for upvoting, and high liquidity for exchange-value into Steem Power or Steem Dollars. Unlike other mining-based systems, in Steem these tokens are constantly produced for a common pool, available to any user (Thelwall, 2018). In this sense, the platform does provide a common capital for use within the project. Steem Power, on the other hand, is used as an influence tool: the more a user holds, the more weight their votes have. It is however, slow to exchange (or "power down") back into STEEM, so it enhances influence (and governance, in the platform context) at the expense of exchange. Finally, Steem Dollars allow the users to exchange their earning into other currencies, by using a USD dollar-pegged system, thus controlling volatility. Authors that are upvoted, or users that identify future high-value posts are

rewarded with Steem Dollars. This hybrid use of interchangeable tokens represents different stages of a peer in a blockchain project: the user of the Steem system has an option to produce, and decide upon the content of the platform from a common pool of capital, while also the possibility to exchange earnings either into leverage for decision-making, or into other currencies.

Although Steem has been operational since 2016, and has (until October 2018) handed out 40 million USD using its reward token economy model (Kim & Chung, 2019), the platform advertises itself as a beta version. Not only in relation to the open code that runs underneath it, but also highlighting the work-in-progress condition of its token economy model. What experimental projects like Steem show is that, through the architecture of these systems, hybridity is being put at play in different forms: regulated through an algorithmically driven command and control, adopting a shared capital and performing different types of co-production, yet driven by exchange signals, and so, within a market paradigm, but stretching its limits through experimentation.

9. Conclusion

Bitcoin and other blockchain initiatives have been categorized as “Distributed capitalism” (Bauwens et al., 2017), a decentralized but extractive model, supported by P2P infrastructures, but still driven by individual profit. In opposition to the extractive pole stands a generative model, which differentiates itself due to adding “common good” value to communities. What examples like Civil or Steem show is that blockchain-based projects may well be market driven, but not in direct opposition to creating community social value. The evolution of blockchain-based projects shows the interplay of fluid elements that accommodate different parts of their system alongside a broad spectrum of traditional coordinates, even if within a market-born paradigm. The token-based, exchange-guided,

and speculation-bound architecture of the blockchain locates its initiatives within Benkler's (and Coase's) mode of production, effectively within the political economy field of markets and firms, with the market as a guiding blueprint. However, the degrees and roles of participation, the definition of a common, and the generative or extractive modes, fluctuate greatly depending on particular undertakings. The variables of development, governance, infrastructure, tokenization, and production are combined, as shown previously, in significantly different ways, pushing our understanding of what constitutes peers, peer production, markets, hierarchies and how these always already troubled notions enter into heady new hybrid relations. The *peer* of blockchains, whether as (lonely old Bitcoin) miner, as token exchanger, Civil or Steem contributor, proposer of BIPs, is not a consistent identity.

The fascination that currently fuels blockchains is encouraging new forms of experimentation and sparking the imagination of participants. Even considering its architecture constraints and its market paradigms, this technology has pushed the conceivability not only of new types of economies, but of co-designed systems that seek to address current cultural needs, fluid dynamics of exchange, and mixed modes of production, creation, and collaboration. The quantity and diversity of blockchain-based decentralized applications, even if not all become realized, is a testimony to both the need and interest for production within and beyond traditional market and firm paradigms. What is more, the reinvigorated experimentation with blockchains, has encouraged non-blockchain based P2P systems (cf. the DAT protocol, the Interplanetary File System, or the Scuttlebutt protocol, to name a few) which embody different politics and interpretations of what is entailed by co-production, and use blockchains merely as a subsystem, thus folding blockchains into political and economic imaginaries beyond those that have shaped Bitcoin and other blockchains. Perhaps the most interesting quality of blockchains and blockchain-

based projects is how they constantly reconfigure and push at the boundaries of peer, market and hierarchical organization; less a ‘third mode’ than an erosion of modal thought. Blockchains are always already hybrid. They force those invested in peer production to proceed with caution, without the certainty of historical destiny or an assumed moral high ground – a peer production without guarantees.

References

- Agre, P. E. (2003). P2P and the promise of internet equality. *Communications of the ACM*, 46(2), 39. <https://doi.org/10.1145/606272.606298>
- Alqassem, I., Rahwan, I., & Svetinovic, D. (2018). The Anti-Social System Properties: Bitcoin Network Data Analysis. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, 1–11. <https://doi.org/10.1109/TSMC.2018.2883678>
- ArtID Marketplace. (n.d.). Retrieved March 28, 2019, from <https://artid.ch/Site/Index>
- Bauwens, M, Kostakis, V., & Pazaitis, A. (2017). *Peer to Peer: the Commons Manifest*. London: University of Westminster Press.
- Bauwens, Michel. (2005). The Political Economy of Peer Production. *CTheory*, 0(0), 12-1/2005.
- Beckert, J., & Aspers, P. (Eds.). (2011). *The Worth of Goods: Valuation and Pricing in the Economy*. New York: OUP Oxford.
- Benkler, Y. (2002). Coase's Penguin, or, Linux and "The Nature of the Firm." *The Yale Law Journal*, 112(3), 369–446. <https://doi.org/10.2307/1562247>
- Benkler, Y. (2006). *The Wealth of Networks: How Social Production Transforms Markets and Freedom* (1st Edition edition). New Haven Conn.: Yale University Press.
- Beverungen, A., Mirowski, P., Nik-Khah, E., & Schröter, J. (2019). *Markets*. Minneapolis: Meson Press.
- Çalışkan, K. (2010). *Market Threads: How Cotton Farmers and Traders Create a Global Commodity*. Princeton University Press.
- Coase, R. H. (1937). The Nature of the Firm. *Economica*, 4(16), 386–405. <https://doi.org/10.1111/j.1468-0335.1937.tb00002.x>
- Coeckelbergh, P. D. M. (2015). *Money Machines: Electronic Financial Technologies*,

Distancing, and Responsibility in Global Finance. Surrey: Ashgate Publishing Limited.

De Filippi, P. (2015, July 31). *Commons Governance and Law with Primavera De Filippi* (R. O'Dwyer, Interviewer). Retrieved from <http://commonstransition.org/commons-centric-law-and-governance-with-primavera-de-filippi/>

De Filippi, P., & Loveluck, B. (2016). The invisible politics of Bitcoin: governance crisis of a decentralised infrastructure. *Internet Policy Review*, 5(3). <https://doi.org/10.14763/2016.3.427>

De Jong, E., Tkacz, N., & Velasco González, P. (2015). “Live as Friends and Count as Enemies”: On Digital Cash and The Media of Payment. In G. Lovink, N. Tkacz, & P. De Vries (Eds.), *MoneyLab Reader: An Intervention in Digital Economy* (pp. 257–267). Amsterdam: Institute of Network Cultures.

DuPont. (2019, March 22). New Book Reveals Crypto’s Radical Origins. Retrieved April 11, 2019, from BREAKERMAG website: <https://breakermag.com/new-book-reveals-cryptos-radical-origins/>

Ethereum Project. (n.d.). Retrieved September 11, 2017, from <https://www.ethereum.org/>

Ghoshal, S., & Moran, P. (1996). Bad for Practice: A Critique of the Transaction Cost Theory. *Academy of Management Review*, 21(1), 13–47. <https://doi.org/10.5465/amr.1996.9602161563>

Gianelli, G., & Fumagalli, A. (2013, December 17). Il fenomeno Bitcoin: moneta alternativa o moneta speculativa? - Gianluca Giannelli e Andrea Fumagalli. Retrieved March 11, 2019, from Effimera website: <http://effimera.org/il-fenomeno-bitcoin-moneta-alternativa-o-moneta-speculativa-gianluca-giannelli-e-andrea-fumagalli/>

- Golumbia, D. (2016). *The Politics of Bitcoin: Software as Right-Wing Extremism*. Minneapolis: Univ Of Minnesota Press.
- Hall, S. (1986). The Problem of Ideology-Marxism without Guarantees. *Journal of Communication Inquiry*, 10(2), 28–44.
<https://doi.org/10.1177/019685998601000203>
- Iles, M. (2018, May 4). The Civil Constitution (Beta). Retrieved March 31, 2019, from Civil website: <https://blog.joincivil.com/the-civil-constitution-beta-64460a181e08>
- Kim, M. S., & Chung, J. Y. (2019). Sustainable Growth and Token Economy Design: The Case of Steemit. *Sustainability*, 11(1), 167. <https://doi.org/10.3390/su11010167>
- Lovink, G., Tkacz, N., & De Vries, P. (Eds.). (2015). *MoneyLab Reader: An Intervention in Digital Economy*. Retrieved from <http://networkcultures.org/blog/publication/moneylab-reader-an-intervention-in-digital-economy/>
- Maurer, B. (2005). *Mutual life, limited: Islamic banking, alternative currencies, lateral reason*. Princeton, N.J.: Princeton University Press.
- Mirowski, P. (Ed.). (2015). *The Road from Mont Pèlerin: The Making of the Neoliberal Thought Collective, With a New Preface* (New edition). Harvard University Press.
- MIT License. (2019). In *Wikipedia*. Retrieved from https://en.wikipedia.org/w/index.php?title=MIT_License&oldid=890561606
- Nakamoto, S. (2008). *Bitcoin: A peer-to-peer electronic cash system*. Retrieved from <https://bitcoin.org/bitcoin.pdf>
- O'Dwyer, R. (2014, September). *Other Values: Considering Digital Currency as a Commons*. Presented at the Creating Cracks: Value, Commons, and Alternative Economy, London.
- Raymond, E. S. (2008). *The Cathedral & the Bazaar: Musings on Linux and Open Source*

by an Accidental Revolutionary. O'Reilly Media, Inc.

Reijers, W., Wuisman, I., Mannan, M., De Filippi, P., Wray, C., Rae-Looi, V., ... Orgad,

L. (2018). Now the Code Runs Itself: On-Chain and Off-Chain Governance of Blockchain Technologies. *Topoi*. <https://doi.org/10.1007/s11245-018-9626-5>

Schaffers, H. (2018). The Relevance of Blockchain for Collaborative Networked

Organizations. In L. M. Camarinha-Matos, H. Afsarmanesh, & Y. Rezgui (Eds.), *Collaborative Networks of Cognitive Systems* (pp. 3–17). Springer International Publishing.

Steemit. (n.d.). Retrieved April 3, 2019, from Steemit website: <https://steemit.com/>

Swartz, L. (2017). Blockchain Dreams: Imagining Techno-economic Alternatives After Bitcoin. In *Another Economy is Possible: Culture and Economy in a Time of Crisis* (1 edition). Malden, MA: Polity.

Swartz, L., & Driscoll, K. (2017, July 19). The Lonely Old Bitcoin Miner Touches Eternity Or, What is a Peer? Retrieved January 16, 2019, from King's Review Magazine website: <http://kingsreview.co.uk/articles/lonely-old-bitcoin-miner-touches-eternity-peer/>

Taylor, M. B. (2013). Bitcoin and the Age of Bespoke Silicon. *Proceedings of the 2013 International Conference on Compilers, Architectures and Synthesis for Embedded Systems*, 16:1–16:10. Retrieved from <http://dl.acm.org/citation.cfm?id=2555729.2555745>

Terranova, T. (2009). Another Life: The Nature of Political Economy in Foucault's Genealogy of Biopolitics. *Theory, Culture & Society*, 26(6), 234–262. <https://doi.org/10.1177/0263276409352193>

The Tao of IETF: A Novice's Guide to the Internet Engineering Task Force. (2012, August). Retrieved May 2, 2016, from <https://www.ietf.org/tao.html>

- Thelwall, M. (2018). Can social news websites pay for content and curation? The SteemIt cryptocurrency model. *Journal of Information Science*, 44(6), 736–751.
<https://doi.org/10.1177/0165551517748290>
- Tkacz, N. (2011). The politics of forking paths. In G. Lovink & N. Tkacz (Eds.), *Critical point of view : a Wikipedia reader* (pp. 94–109). Retrieved from
<http://networkcultures.org/wpmu/portal/publications/inc-readers/critical-point-of-view-a-wikipedia-reader/>
- Tkacz, N. (2015). *Wikipedia and the Politics of Openness*. Chicago ; London: University of Chicago Press.
- UN City Copenhagen, P. D. C. (2017, May 30). Blockchain Against Hunger: Harnessing Technology In Support Of Syrian Refugees. Retrieved April 3, 2019, from UN.DK website: <http://un.dk/news-and-media/blockchain-against-hunger-harnessing-technology-in-support-of-syrian-refugees>
- Velasco, P. R. (2016). Superabundant design: from waste to control in Bitcoin mining. *A Peer-Reviewed Journal About*, 5(1). Retrieved from <http://www.aprja.net/?p=2927>
- Vuong, N. (2018, May 18). The Civil Registry: a TCR for Quality Journalism. Retrieved March 31, 2019, from Civil website: <https://blog.joincivil.com/the-civil-registry-a-tcr-for-quality-journalism-a2452f363665>
- Weber, S. (2004). *The success of open source*. Harvard University Press.