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What the History of Linux Says About the Future of Cryptocurrencies

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Abstract:

Since Bitcoin's meteoric rise, hundreds of cryptocurrencies that people now publicly trade have emerged. As such, the question naturally arises: how have cryptocurrencies evolved over time? Drawing on the theory of polycentric information commons and cryptocurrencies' historical similarities with another popular information commons (namely, Linux), we make predictions regarding what cryptocurrencies may look like in the future. Specifically, we focus on four important historical similarities: 1) support from online hacker communities, 2) pursuit of freedom, 3) criticism about features and use, and 4) proliferation of forks. We then predict that: 1) cryptocurrencies will become more pragmatic rather than ideological, 2) cryptocurrencies will become more diverse in terms of not only the underlying technology but also the intended audience, and 3) the core technology behind cryptocurrencies, called blockchain, will be successfully used beyond cryptocurrencies.

Keywords: Bitcoin, Blockchain, Cryptocurrencies, Information Commons, Linux.

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1 Introduction

In 2009, Nakamoto (2008) birthed a revolutionary concept, the online currency Bitcoin. Bitcoin requires no centralized authority since it functions as a peer-to-peer electronic cash system. Further, Bitcoin relies on a cryptography-based distributed record system now referred to as blockchain. Given that Bitcoin represents the first and most popular cryptocurrency, it has well-known fundamental issues, such as the amount of electricity its proof-of-work consensus mechanism requires (Kugler, 2018). Various actors have since proposed myriad cryptocurrencies that address some of the issues with Bitcoin's blockchain and/or that focus on a different domain/audience. As of March, 2019, 2,125 actively traded cryptocurrencies exist (CoinMarketCap, 2019). Some even began due to a joke. For example, one individual created Garlicoin after posting on Reddit on 25 December, 2017: "If this post gets 30,000 upvotes, I will make a garlic bread cryptocurrency" (DigitalizedOrange, 2017). This post has since received over 45,000 upvotes, and, as of March, 2019, Garlicoin had a market cap of US$36,870.

In all fairness, after the hype surrounding cryptocurrencies quietens, many of those coins will likely fade away. Accordingly, the question arises: what are the factors likely to determine the sustainability of cryptocurrencies? As one can expect, it is very hard to precisely pinpoint which cryptocurrencies will stand the test of time, although some evidence shows that online search frequency and the volume of trade in non-cryptocurrency financial markets affect cryptocurrency-trading volume (Jerdack, Dauletbek, Divine, Hult, & Carvalho, 2018). In this commentary, we do not attempt to predict which cryptocurrencies will stand the test of time. Instead, we focus on understanding what cryptocurrencies might look like in the future. After carefully analyzing cryptocurrencies' short history and current state, we found similarities between cryptocurrencies and the open source operating system Linux. In particular, we empirically observed that, similar to Linux, a strong community of like-minded hackers who have strong libertarian views have backed several cryptocurrencies. Moreover, both Linux and cryptocurrencies have received their fair share of criticism concerning some of their features and usage and the proliferations of forks.

We use these empirical historical observations to look into the future. Specifically, given that Linux has existed for about two decades more than the first cryptocurrency (Bitcoin), we examine whether the former's development can say anything about the latter's future. We then postulate that, based on how Linux has evolved, cryptocurrencies will become less ideological and more business friendly and diverse both in terms of technology and intended audience. Moreover, like the Linux kernel, the core technology behind cryptocurrencies, blockchain, has tremendous potential to succeed in other domains.

Although most of our observations have an empirical nature, we nonetheless focus on providing a theoretical basis for the similarities we found between Linux and cryptocurrencies and for our predictions regarding the latter. To do so, we draw on the recently proposed theory of polycentric information commons (Mindel, Mathiassen, & Rai, 2018). We start by noting that, being primarily public blockchains, most cryptocurrencies allow one to easily access all their transactions. Moreover, anyone can immediatelly create private and public encryption keys via a wallet to immediately start transacting with others. Finally, a cryptocurrency ecosystem's stability relies on several users who compete to validate and broadcast blocks of valid transactions, which one can see as a form of mutual accountability. Nonetheless, those users can freely stop supporting the system whenever they want to, which highlights cryptocurrencies' openness to participation. The above properties show how one can appropriately cast cryptocurrencies as polycentric information commons.

Polycentric information commons are highly accessible, decentralized online information systems whose stakeholders share an overarching goal (Mindel et al., 2018). Moreover, in these information systems, information emerges in an unorganized fashion from individual providers' actions. Some well-known examples include the operating system Linux, the Web browser Mozilla Firefox, the online encyclopedia Wikipedia, the Q&A platform Quora, the social network Facebook, and the video-sharing platform YouTube.

Three major characteristics differentiate information commons from other information systems and determine the polycentric nature of their governance: 1) ease of access, 2) openness to participation, and 3) mutual accountability. Ease of access means users experience no or few barriers to actively consume and produce information (e.g., anyone can download, use, and develop software for an open source Linux distribution). Openness to participation means users can freely consume and produce content for the system as they wish (e.g., volunteers who contribute to an open source, Linux-based operating system can stop doing so at any time). Mutual accountability means the system's stability stems from a high

degree of inclusivity (e.g., the Linux kernel has several maintainers responsible for different system components who analyze patches that thousands of developers all over the world suggest).

To the best of our knowledge, our work constitutes the first study to suggest the theory of polycentric information commons as the theoretical underpinning for studying cryptocurrency ecosystems' sustainability and open source operating systems such as Linux. Note that, although cryptocurrencies use blockchain technology as their core mechanism, its use has begun to evolve beyond cryptocurrencies. Defining blockchain now has become a daunting task given the ever-increasing number of blockchain models. For example, some blockchain models do not even use linear blocks (e.g., IOTA's model), and others are simply adaptations of relational models (e.g., ChomaWay's Postchain).

The above said, one can broadly categorize the applications of blockchain models into two categories: public blockchains and permissioned blockchains. Nearly all cryptocurrencies are public blockchains, which means that anyone can join the network and engage in transactions; therefore, cryptocurrencies represent polycentric information commons. Most current enterprise applications, however, are permissioned blockchains, which means that users need permission to join the network or even read or write data to the blockchain (e.g., see Hyperledger Fabric/Composer model). Further, in permissioned blockchains, few members typically control governance (see Walmart's Food Trust or Maersk's TradeLens). Therefore, permissioned blockchains do not represent polycentric information commons, and they differ drastically from a polycentric information commons such as Linux whether in terms of openness, ideology, or governance. In our study, we examine specific public blockchains (namely, cryptocurrencies) rather than permissioned blockchains.

2 Emergent Research on Cryptocurrencies in Information Systems

The disruption that cryptocurrencies have created, such as their ability to remove intermediaries and allow for instantaneous cross-border payments, has sparked great research interest in the information systems (IS) community. Given that cryptocurrencies constitute online currencies, researchers have usually studied them under the financial technology (FinTech) umbrella (Gomber, Kauffman, Parker, & Weber, 2018), an emerging field that uses information technologies to improve activities in finance. Some specific research that IS researchers have conducted in this area include: 1) understanding what might affect cryptocurrency prices (Cai, Liu, Lim, Tan, & Zheng, 2018; Mai, Shan, Bai, Wang, & Chiang, 2018), 2) issues surrounding the novel crowdfunding-like method for raising funds called initial coin offerings (Chanson, Gjoen, Risius, & Wortmann, 2018; Guske & Bendig, 2018; Park & Yang, 2018), and 3) the potential benefits and drawbacks of smart contracts (i.e., computer programs that can carry out the terms of a contract between two or more parties) (Hans, Zuber, Rizk, & Steinmetz, 2017; Gilcrest & Carvalho, 2018; Gonzalez Rivas, Tsyganova, & Mik, 2018).

Recognizing the value of blockchain beyond cryptocurrencies, IS researchers have also investigated managerial issues about deploying blockchain models, such as governance (Beck, Müller-Bloch, & King, 2018; Lacity, 2018) and adoption (Post, Smit, & Zoet, 2018; Sadhya & Sadhya, 2018), and developed frameworks and taxonomies that assess and/or classify blockchain applications and related business models (Beinke, Ngoc, & Teuteberg, 2018; Kaul, Storey, & Woo, 2018; Salviotti, De Rossi, & Abbatemarco, 2018).

We contribute to the literature by analyzing cryptocurrencies' past and future through the lens of the theory of polycentric information commons (Mindel et al., 2018). Given our work (to the best of our knowledge) represents the first study to describe cryptocurrencies as an information commons, we open up new possibilities for studying the sustainability of cryptocurrency and, broadly speaking, blockchain ecosystems.

3 Theoretical Background

We draw on the theory of polycentric information commons (Mindel et al., 2018) and examples from historical similarities between the evolution of Linux, a popular information commons, and cryptocurrencies to make predictions regarding the latter's possible future. However, first, we recognize and differentiate between the *phenomenon* of an information commons and a *platform* for it. For example, online reviews are a phenomenon where people can post reviews about businesses, products, or services, but such reviews can appear on many different platforms, such as Yelp, TripAdvisor, and the Internet Movie Database (IMDB). Each platform differs from the others in various ways (e.g., they may

focus on a specific audience or goal). For example, IMDB focuses on movie reviews and ratings, and its content differs remarkably from content on Yelp. Nevertheless, platforms may also share their overarching goals and compete against one another. For example, the social network and media platforms Facebook, MySpace, Friendster, Orkut, and Google+ compete (or rather competed) for market share.

Each information commons phenomenon has a unique story; accordingly, so does each platform that focuses on it. Therefore, one would find it difficult (if not impossible) to postulate what new phenomena may arise, whether and how they can disrupt business practices and social fabrics, and which platforms will stand the test of time. After they become well established, phenomena tend to sustain the test of time. However, platforms face challenges to survive, and digital business strategies and business models have been the key differentiators as to which ones do (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013). Accordingly, we consider cryptocurrency as the phenomenon, and individual coins such as Bitcoin, Bitcoin Cash, and Monero as the platforms that compete with each other. The coins (platforms) might be ephemeral, whereas the cryptocurrency concept (phenomenon) has the potential to last forever. Similarly, one can think of Linux as a phenomenon representing open source operating systems and individual Linux-based distributions as the underlying platforms.

Under the above background, we consider Linux to postulate about cryptocurrencies' future for three reasons. First, both Linux and cryptocurrencies are information commons envisioned to create secure and powerful alternative platforms against well-established and tightly controlled platforms. Linux was created to override the constraints imposed by proprietary operating systems. Cryptocurrencies, in turn, were first created to override geographical limitations and to allow users to use a currency free of governmental interferences.

Second, for both cryptocurrencies and Linux, the phenomenon and corresponding platform were conceived simultaneously unlike some other platforms that came after the birth of a phenomenon. To elaborate with an example, although Wikipedia and YouTube could be considered new platforms when they were first proposed, the wikis/encyclopedias and (digital) media sharing already existed.

Third, information commons such as online reviews, social media, and media sharing are content driven and, hence, heavily influenced by providers (i.e., those who create content) and appropriators (i.e., those who consume content). Indeed, their underlying communities more often discuss content and its impact on the general population and stakeholders rather than platforms' existing features and new capabilities. On the other hand, producers (i.e., those who construct, repair, and take actions for the platform's sustainability) heavily influence Linux and cryptocurrencies. The community focuses on platforms' capabilities and how they can further customize and improve them. In this case, the platform's content does not have as much significance. For example, a developer (and users) can develop (use) several Linux apps for purposes that might not have much bearing on other Linux users and the society in general. The same point remains true when one considers a single transaction in a cryptocurrency ecosystem.

For the above-mentioned reasons, we focus on drawing similarities between cryptocurrencies and Linux to postulate how cryptocurrencies may evolve over time. Rooted in the conceptual model that Mindel et al. (2018) propose, we identify four prominent features of cryptocurrencies' evolution that have similarities with Linux: 1) support from online hacker communities, 2) pursuit of freedom, 3) criticism about features and usage, and 4) proliferation of forks. We elaborate on each similarity in Section 4.

4 Similarities

4.1 Similarity 1: Support from Online Hacker Communities

The theory of polycentric information commons emphasizes an information commons' ability to continuously provide value to its stakeholders in order to sustain itself. Provision and appropriation represent two key factors that determine whether any polycentric information commons will succeed. Provision refers to the extent to which participants continuously contribute to an information commons. Appropriation refers to the extent to which participants consume or extract value from an information commons. Provision and appropriation collectively determine the extent of support an information commons receives from its community. Drawing on the provision and appropriation ideas, the basis of the first similarity between cryptocurrencies and Linux is the creation of a platform by a single individual that was eventually supported by a group of like-minded hackers.

Linus Torvalds, a student from the University of Helsinki, created Linux in 1991 when he started hacking his recently acquired PC. After developing a rudimentary task-switching program, Linus realized he had to download some files, which naturally required him to develop a disk driver to read/write files to a disk. Finally, he had to develop a file system, after which the first Linux kernel emerged. Like-minded hackers from the MINIX newsgroup helped him on the entire development process. Moddy (1997) has estimated that about 100 users used and fixed problems in the original kernel by 1992. Without a strong community providing and consuming content (e.g., developing and using apps), Linux would likely not be as successful as it is today. In other words, according to the theory of polycentric information commons, Linux's sustainability would be in jeopardy.

In 1992, the Cypherpunk mailing list also emerged. This mailing list provided a platform for individuals concerned about online privacy to talk about, among other things, using cryptographic protocols to secure communications. Given group members' strong libertarian inclination, they often discussed the idea of a decentralized, private, and digital currency as a way to separate money from the government. Years later, the elusive Satoshi Nakamoto shared the white paper describing Bitcoin's mechanics on this same list (Nakamoto, 2008). Many members of the Cypherpunk mailing list eventually tested, promoted, and helped Nakamoto with developing Bitcoin. These members also first created "content" in the Bitcoin ecosystem (i.e., transactions and blocks of transactions). As with Linux and any polycentric information commons, a cryptocurrency that lacks support from a community (providers, appropriators, and producers) will quickly perish.

For both Linux and Bitcoin, one can see how the underlying community proved crucial in terms of both adoption (provision/appropriation) and development. Mindel et al. (2018) have postulated this shared accountability and incremental adaption of governance rules to positively affect a polycentric information commons' sustainability, which might help explain why Linux and Bitcoin have succeeded.

4.2 Similarity 2: Pursuit of Freedom

Apart from provision and appropriation, the theory of polycentric information commons also emphasizes revitalization and equitability as key factors for a polycentric information commons' sustainability. Revitalization refers to the rate of provision between new and disengaged providers. Equitability refers to the extent to which providers share provision activities. Given that the participants do not must to actively engage in an information commons, prior studies have suggested that a collective ideology and shared goals bring participants together to develop and sustain a polycentric information commons (Stewart & Gosain, 2006). Freedom from forced authoritative compliance served as the basis for the ideology behind both Linux and modern cryptocurrencies. Accommodating the entry of outsiders with new ideas (i.e., encouraging revitalization) and allowing a broad range of participants to actively contribute (i.e., encouraging equitability) were propagated to further this pursuit of freedom, which constitutes the second similarity between Linux and cryptocurrencies.

After experiencing the MINIX operation system that Andrew Tanenbaum developed, Linus Torvalds did not like its underlying licensing and fees. After Tanenbaum stated that he developed MINIX as a hobby, Torvalds stormed on the MINIX newsgroup:

> *You doing minix as a hobby—look at who makes money off minix, and who gives linux out for free. Then talk about hobbies. Make minix freely available, and one of my biggest gripes with it will disappear*. (DiBona & Ockman, 1999)

Torvalds found MINIX's cost outrageous, and the freedom from paying these fees constituted a big factor in his decision to develop Linux (Tozzi, 2017). This ideology also constituted a strong factor in bringing in new contributors to the cause (revitalization) and encouraging old contributors to continue contributing (equitability).

On the other hand, the fallout from the 2008 financial crisis apparently motivated Nakamoto to develop Bitcoin. In particular, Nakamoto added the following line of text alongside transaction data to Bitcoin's genesis block: "The Times 03/Jan/2009 Chancellor on brink of second bailout for banks". Given the referenced time, the text strongly seems to reference the 2008 financial crisis. In a post on the P2P Foundation's forum in February, 2009, Nakamoto elaborated on his libertarian view:

> *I've developed a new open source P2P e-cash system called Bitcoin. It's completely decentralized, with no central server or trusted parties, because everything is based on crypto proof instead of trust…. The root problem with conventional currency is all the trust that's*

> *required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust. Banks must be trusted to hold our money and transfer it electronically, but they lend it out in waves of credit bubbles with barely a fraction in reserve…. With e-currency based on cryptographic proof, without the need to trust a third party middleman, money can be secure and transactions effortless.* (Nakamoto, 2009)

In other words, Nakamoto developed Bitcoin to gain freedom from third-party institutions to guarantee transactions and secure a currency's value. Given Bitcoin's success, one can argue that its ideology has been a strong factor in attracting new and retaining old members, which positively affects Bitcoin's sustainability according to the theory of polycentric information commons.

4.3 Similarity 3: Criticism about Features and Usage

As we mention in Section 3, any polycentric information commons has three stakeholder categories: producers, providers, and appropriators. Whether and how these key stakeholders derive value determines an information commons' sustainability. In particular, as we discuss in Section 4.2, provision represents a key sustainability factor since its absence create significant hurdles in the growth of an information commons where stakeholders might be unable to extract proportionate benefits for their time and effort. A lack of and/or unethical provision often results in criticism about the platform.

Throughout the years, Linux and cryptocurrencies alike have received their fair share of criticism concerning some of their features and usage, which one can partially attribute to insufficient provision. For example, the desktop version of Linux has received criticism for lacking popular software, including certain games and native applications from IT giants such as Microsoft and Adobe. Cryptocurrencies also face provision issues in that many retailers still do not accept them, which, in turn, implies that they have fewer produced transactions ("content") than they could have.

Arguably, the number one criticism concerning cryptocurrencies involves their usage in illegal transactions, which one can see as unethically providing "content" when one considers transactions the artifact that providers create. Foley, Karlsen, and Putniņš (2018) estimated that, as of April, 2017, 25 percent of all Bitcoin users and 44 percent of all Bitcoin transactions were associated with illegal activities. Many of these transactions occurred on the now defunct online black market called the Silk Road, where users could buy drugs, fake products, and even child pornography. Bitcoin has also received criticism for consuming too much electricity to solve computational puzzles during mining operations, which one can see as providing "content" when one now considers blocks of transactions as the artifact that providers create. In particular, Kugler (2018) has estimated that the Bitcoin network consumes the astronomical amount of 0.29 percent of the world's annual electricity consumption.

However, one can somewhat counter these criticisms. For example, one can see the different transaction domains that involve cryptocurrencies as an expression of freedom of choice. One can also claim that traditional financial systems require a tremendous amount of electricity to stay alive as well. Overall, despite fair criticisms regarding provision, both Linux and the cryptocurrency space continue to thrive. For example, the public widely uses the Linux-based operating system Android, and many legitimate businesses, including Windows and Xbox stores, now accept cryptocurrencies.

4.4 Similarity 4: Proliferation of Forks

According to the theory of polycentric information commons, collective action threats represent a key aspect that adversely affects information commons' sustainability. In particular, Mindel et al. (2018) identify free-riding, congestion, pollution, violation, and rebellion as making up collective action threats. When participants lack satisfaction with a platform, they can either move to another platform or influence the underlying community to an extent that it will inevitably create an alternative platform. Building on this idea, we suggest that the proliferation of forks poses a significant threat that has influenced how Linux and cryptocurrencies have evolved.

Linux has suffered from a seemingly uncontrolled proliferation via forks of its kernel. In particular, as of May, 2019, 303 active distributions exist according to distrowatch.com. On the one hand, some of these distributions contain real improvements and/or new features (e.g., different package management tools) and might target different audiences/applications (e.g., Web servers and forensics/cybersecurity). On the other hand, some distributions add minor and sometimes redundant changes to existing distributions. This lack of consolidation might confuse new users and negatively affect Linux's adoption. In particular, from

January, 2012, to February, 2019, Linux never had more than a three percent share of the desktop, tablet, and console device market (Statistica, 2019).

We have seen a similar phenomenon with cryptocurrencies. For example, anyone can at any time download Bitcoin's source code and immediately release the same coin under a different name or with slight modifications. Such cryptocurrencies include Dash, Bitcoin Cash, Bitcoin Private, and BitConnect. The growing number of coins causes difficulties when cryptocurrency investors have to value the volatile and oftentimes thinly traded coins. It also prompts concerns about pump-and-dump schemes. Specifically, a scammer can try pumping the price of a new coin up by exaggerating its value and technical merits. In the future, that scammer can eventually sell ("dump") coins when the prices rise to reap a profit. Although uncontrolled proliferations might pose a concern, unoriginal cryptocurrencies and Linux distributions will not likely stand the test of time since they lack a supporting community that helps with, for example, patches or mining operations.

5 Looking into the Future

Above, we explore how cryptocurrencies and Linux have evolved in a similar way. Given that Linux has existed for around 15 years longer than Bitcoin, the first cryptocurrency, the question arises: what does Linux's evolution say about cryptocurrencies' future? First, we expect a more pragmatic rather than ideological approach to drive cryptocurrencies' development. Similar to how some enterprise Linux distributions are not necessarily free and, thus, abandon its original freeware ideology, we expect some cryptocurrencies to depart from the libertarian, cypherpunk principles in favor of a more business-friendly approach. For example, the idea of a completely anonymous banking system might not appeal to some organizations, which might want to know who they transact with. This can even be mandatory due to regulations such as the USA Patriot Act's Know Your Customer. Similarly, due to strategic reasons, companies might not want to have all their transactions available on a public blockchain. As such, we believe that privacy might partially replace anonymity in the future. This idea has begun to gain traction with the company Ripple Lab. and its XRP Ledger network, a private blockchain that does not preserve anonymity. Consequently, financial institutions find this blockchain model more appealing as one can see from its list of investors, such as Santander InnoVentures and the CME Group.

In the near future, we also expect cryptocurrencies to become more diverse in terms of not only their underlying technology but also their intended audience. In this sense, we expect some cryptocurrencies to follow a path similar to that of Linux, where some distributions are specializing in certain domains. For example, Dyne:bolic focuses on multimedia production, whereas Kali Linux focuses on forensic and cybersecurity. Most cryptocurrencies today allow users to use them for any general purpose, but we have begun to see more specific cryptocurrencies emerge. For example, Ripple targets players in the traditional banking field and hopes to become the new SWIFT system. Whoppercoin, a cryptocurrency that Burger King in Russia launched to reward customers after they purchase a Whopper sandwich, represents another example.

Finally, similar to how other devices such as smartphones (Android) and supercomputers (UNICOS) now use the Linux kernel, we expect blockchain to see wider use beyond cryptocurrencies. As of March, 2019, we found several reports on blockchain pilots, such as Walmart and IBM using blockchain technologies to address food and diamond supply chain provenance. Popular open source frameworks such as Hyperledger Fabric (Androulaki et al., 2018) enable individuals to quickly develop and deploy private blockchains. It comes as no surprise that the Linux Foundation currently hosts the Hyperledger project. As we note in Section 1, some recent advances in the blockchain technology depart drastically from the initial ideology behind Bitcoin and most cryptocurrencies. Specifically, several enterprise blockchain applications rely on a permissioned model, which means that users require permission to join the network or even to read data or write data to the blockchain. Moreover, all network members know each other and, thus, lack anonymity. These features drastically depart from Bitcoin's and most other cryptocurrencies' ideology and open nature. That said, although we may see several similarities in how cryptocurrencies and Linux have developed, the same does not necessarily apply when we focus on blockchain as an independent technology.

The predictions we make above extend the views that Fitzgerald (2006) expressed more than a decade ago. In particular, Fitzgerald explained how open source software, such as Linux, transitioned from being a highly ideological information commons that its creator developed to pursue freedom from arbitrary controls to an information commons with a market-focused orientation:

> *The open source phenomenon has undergone a significant transformation from its free software origins to a more mainstream, commercially viable form—OSS* [Open Source Software] *2.0, as I term it.* (Fitzgerald, 2006, p. 587)

One can also argue that cryptocurrency and blockchain organizations are undergoing a similar trend. For example, Consensys, a prominent blockchain software technology company that began in 2015, laid off 13 percent of its workforce in December, 2018, to shift its focus from primarily "cool" projects to commercially viable projects and long-term value creation. As its founder, Joe Lubin, reported:

> *We've definitely been more focused on doing cool things in the past, and now we're just focused on being a set of viable and successful businesses in a real business ecosystem.... Blockchain is getting very, very real. It's about the maturation of the company*." (Seward, 2019)

Once again, the theory of polycentric information commons can explain how both Linux and cryptocurrency/blockchain companies have changed over time. In particular, supporting an information commons may require ongoing investments and recurring costs, such as salaries, domain names, servers, and so on. If a producer has no real returns (i.e., value) from architecting and maintaining the infrastructure of an information commons, then the information commons will likely lack sustainability. One can see organizations transitioning towards more business-friend platforms not only as an effort to be more effective and efficient but also to keep the underlying phenomenon alive.

6 Discussion

In this paper, we compared the evolution of two information commons, Linux and cryptocurrencies, and postulated what the future of cryptocurrencies may look like. Although similarities and patterns usually form the basis for predicting future outcomes, no two journeys of different information commons are alike. That said, it is also important to note that there might be differences that we did not explore that could lead to alternative outcomes as Table 1 illustrates. For example, although Linux and most public cryptocurrencies follow an open source development model that a strong and active community supports (see Sections 4 and 5), these information commons have different goals. Linux focuses on providing a robust operating system that users can easily tailor to their needs. As such, it has seen use in several domains, such as personal computers, mobile devices, supercomputers, and so on. Cryptocurrencies, on the other hand, enable individuals to perform financial transactions without relying on intermediaries, such as a central bank. While this feature facilitates cross-border payments and remittance, it also raises several legal concerns (e.g., it violates know-your-customer (KYC) and anti-money laundering (AML) laws). Cryptocurrencies' anonymity aspect constitutes one reason why they violate the law, and it has led some countries (e.g., China) to ban individuals from trading certain cryptocurrencies and caused other countries (e.g., North Korea) to embrace cryptocurrencies as a way to circumvent economic sanctions. Moreover, due to the legal issues, one can argue that cryptocurrencies have become stigmatized (Ingram & Morisse, 2018). Although Linux has faced legal (primarily copyright) issues, they pale in comparison to the legal issues that cryptocurrencies face.

As Table 1 shows, one can also argue that their current adoption state differs as well. While relatively few people and organizations have adopted cryptocurrencies, Linux has crossed the chasm to mainstream adoption in part due to the success of the Linux-based operating system Android (see Section 4.3). For example, as of March, 2019, approximately 40 million Bitcoin addresses were in use (Blockchain, 2019), which does not match the actual number of individual users since any user can create an unlimited number of addresses. To put this number in perspective, more than two billion Android (Linux-based) phones were active in 2017 (Popper, 2017). The age of these technologies might partially explain their different adoption rate since Linux, given it has existed for nearly two decades more than Bitcoin, now enjoys more friendly user interfaces and useful features, whereas trading cryptocurrencies still require one to understand complex ideas, such as wallets, and cryptographic concepts, such as private and public keys.

Table 1. Comparison of Linux and Cryptocurrencies across Different Dimensions

Dimension	Linux	Cryptocurrencies
Initial release	1991	2009
Artifact	Operating system	Online currency
Applications	Operating system where developers are free to customize the operating system as per their own business needs	Universal financial transactions free of geographical boundaries and exchange fees
Development model	Open source	Mostly open source
Adoption	Mass adoption	Initial stages
Governance	Decentralized	Mostly decentralized
Legal issues	Limited issues	Several issues

Given the above discussion, we clearly need strong theoretical reasoning to predict cryptocurrencies' future. That said, we support our empirical observations with the theory of polycentric information commons in order to identify key attributes of how Linux and cryptocurrencies have evolved in order to meaningfully compare the two and make predictions about the latter. We note that, to the best of our knowledge, this paper represents the first to treat cryptocurrencies as polycentric information commons, which can create many research opportunities in terms of not only better understanding governance and cryptocurrency systems' sustainability but also potentially validating and refining the theory of polycentric information commons. Nevertheless, Table 1 lists some key differences between cryptocurrencies and Linux that we do not account for. Mindel et al. (2018) acknowledge that researchers must adapt the theory of polycentric information commons to different contexts:

> *The contextual differences between various information commons, and the inevitable differences between study objectives, necessitate the operationalization of measures specific to each research…. The different concepts and constructs we developed and linked should be adapted in future qualitative and quantitative studies*. (Mindel et al., 2018, p. 625)

This opens up an interesting opportunity to build newer, more appropriate theories to study cryptocurrency ecosystems' sustainability and, consequently, ascertain the predictions that we make in this paper. Similar to any predictive endeavor, accurately predicting the future involves much difficulty. Nonetheless, we hope this commentary will help the IS community think about and potentially shape that future.

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