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'BLOCKCHAIN GOOD, BITCOIN BAD': THE SOCIAL CONSTRUCTION OF BLOCKCHAIN IN MAINSTREAM AND SPECIALIZED MEDIA

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ABSTRACT

Blockchain is one of the most widely debated technologies in recent years. Pundits and scholars have described it as a disruptive technology that will impact many sectors of society. Skeptics argue blockchain's popularity is fueled by the media's obsession for the 'next big thing' rather than the intrinsic potential of the technology. In this paper, we follow a social constructivist approach with the aim of explaining how different discourses are creating new meanings about this technology. As Communication scholars, we focus on the role media play in framing debates about blockchain. Our analysis relies on a human coding of the most popular news about blockchain circulating on Twitter from October 2014 to July 2018. The findings show the general attitude about blockchain is predominantly positive. The discourses developing around crypto technologies are complex and multifaceted and indicate a general transition in the rhetorical definition of blockchain.

Keywords: blockchain, Bitcoin, crypto, social media, Twitter, controversy frame analysis.

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1 INTRODUCTION

We are witnessing the discursive and material social shaping of blockchain. The first blockchain technology was released by Satoshi Nakamoto in the aftermath of the 2008 financial crisis in the form of the cryptocurrency Bitcoin. Blockchain elegantly used cryptographic algorithms and peer-to-peer technologies to solve the dual problems of double spending and verifying Bitcoin transactions without having to rely on a trusted third party (Garrod, 2016). It overcame the constraints that formerly limited the diffusion of digital currencies by decentralizing control over Bitcoin creation and exchange (De Filippi, 2013; Mori, 2016; Wang & Vergne, 2017). Today, blockchain has become a model for the development of new decentralized services across a wide range of sectors, such as trade finance, insurance, entertainment, and real estate (Swan, 2015).

Pundits and scholars have described it as a disruptive technology that is capable of radically reforming and reframing the financial sector (Guo & Liang, 2016; McCallum, 2015). Some crypto enthusiasts call blockchain a revolutionary technology that will impact many sectors of society including healthcare, business management and, eventually, democracy (Crosby, 2016; Tapscott & Tapscott, 2017; Underwood, 2016). Skeptics argue blockchain's popularity is fueled by the media's obsession for the 'next big thing' rather than the intrinsic potential of the technology (on the technical limitations of blockchain, see Lemieux, 2016; Tranquillini, 2016).

In this paper, we follow a social constructivist understanding of technology and conceive blockchain as a technical object still open to multiple interpretations (Bijker, Hughes, & Pinch, 2012; Ihde, 1990). We analyze technological controversies surrounding blockchain with the goal of identifying the discourses, beliefs, and persuasive arguments used to interpret blockchain and to describe its current and future applications (Green, 2004; Green, Li, & Nohria, 2009). We argue the media play an important role in framing debates and circulating imaginaries about blockchain.

We build on previous contributions on digital controversy analysis (Marres, 2015; Marres & Moats, 2015) and argue digital media are an effective tool for mapping and exploring public discourses on socio-technical issues. In particular, we view mainstream and specialized media as a way to sample the different discourses used to explain the development of blockchain technologies and foresee their social impact (Feenberg, 2002; Lane, 2016).

The analysis relies on framing and sentiment analysis (Babbie & Benaquisto, 2014; Creswell, 2014). We use Twitter data to observe the circulation of news stories and to track the evolution of the blockchain debate (Faris, Roberts, Etling, & Benkler, 2016). We human coded the most tweeted articles to identify the frames of meaning associated with blockchain, and their evolution over time.

2 FROM BITCOIN TO BLOCKCHAIN 2.0: 10 YEARS OF DISTRIBUTED LEDGER TECHNOLOGIES

'Blockchain' is a broad signifier used to indicate decentralized and distributed ledger technologies. The term itself started surfacing in the in the academic and public discourse in mid-2014 (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016), although distributed ledger technologies have been used since 2009 in the field of cryptocurrency (e.g. Bitcoin). For example, the blockchain Wikipedia page was created in October 2014 ("Blockchain," 2014) although, according to Wikipedia history log, 'Block chain' was first mentioned on the Bitcoin page in April 2010 ("Bitcoin," 2010).

Blockchain-based applications usually involve a peer-to-peer network of mutually untrusting participants, each one recording and verifying all the transactions taking place within the network. Each participant is incentivized to supply the network with the computational power needed to confirm transactions and record them into a distributed ledger (De Filippi & Loveluck, 2016). In cryptocurrency applications, this participation is compensated with newly minted currency units. The resulting data structure is known as the blockchain, a ledger holding the historical records of all transactions conducted within the network. Through the use of cryptography and hashing algorithms, this distributed list of records cannot be modified, reordered or erased and all new transactions can only be appended to the ledger (Narayanan & Clark, 2017). In this manner, blockchain solves some fundamental issues which until the 1990s hindered the diffusion of electronic money, e.g. the double spending problem (De Filippi & Loveluck, 2016; Koeppl & Kronick, 2017; Swan, 2015).

Several other variations of blockchain technologies can be found in areas other than cryptocurrency and financial services. Often referred to as 'blockchain 2.0' (Garrod, 2016), examples of these applications include universal online identification systems (Koeppl & Kronick, 2017), blockchain-based decentralized models of crowdfunding and permissioned distributed ledgers applications that only operate within private networks (Swan, 2015).

Blockchain's technological and semantic flexibility is reflected in the proliferation of discourses used by different media outlets for describing the potential of this technology. In the following sections, we analyze mainstream and specialized media with the aim of identifying and mapping these discourses. Our goal is to understand how they might eventually generate a stable and shared understanding of blockchain.

3 COMMUNICATION AND THE SOCIAL CONSTRUCTION OF BLOCKCHAIN

This research is theoretically connected with previous contributions in the fields of Communication and STS. In particular, we study blockchain development through

the lens of Social Constructivism. Constructivism rejects instrumentalist and technological determinist ideas that technologies are socially and politically neutral and the ends pursued through their use are determined by human agency alone (Verbeek, 2005). At the same time, constructivist theories oppose the substantivist's argument that ends are immanent in technology and therefore humans can only pursue the finalities made possible by the available technical means (Feenberg, 2002; Winner, 1978).

The constructivist position addresses the instrumentalist-substantivist dilemma arguing that means and ends are inevitably inter-connected in and through technology. Constructivist scholars argue that such connections are agreed-upon at the societal level. Therefore, the ends pursued by technology are constructed through and by the interactions that social groups develop around new technical objects (Feenberg, 1992; Lane, 2016). These interactions often generate different and diverging interpretations about the meaning of an artefact. The heterogeneity between different interpretations is greatest when a new artefact is introduced in society and diminishes while the competition between different viewpoints unfurls (Feenberg, 2010). The controversy is eventually resolved when a group of actors is capable of strategically imposing their own interpretation of the object on others. In this moment, the artefact loses its interpretative flexibility, which previously allowed it to assume different meanings to different people (Bijker, Hughes, & Pinch, 2012). The closure of the controversy is not achieved by coercion, instead it is a rhetorical maneuver. (Bijker, Hughes, & Pinch, 2012). When a technology is no longer interpretatively flexible it becomes a black box and fades into the technological background (Latour, 1987). This institutionalization reflects that actors take the meanings and uses of the technology largely for granted (Green, Li, & Nohria, 2009).

The development and adoption of blockchain, like most technologies, has important rhetorical and social elements that will shape its meaning and use (Green, Li, & Nohria, 2009). In this paper, we rely on Twitter as a way to explore and analyze the discursive dimension of blockchain, which we conceptualize both analytically and empirically using the concept of technological frame (Bijker, 2012). Framing indicates the signifying work (Snow & Benford, 1988, p. 198) through which different social groups, in our case computer scientists, media, investors, private companies, and the 'public' (among other actors), construct meanings and circulate imaginaries of blockchain and its potential applications. Framing involves the production and maintenance of shared values, beliefs and meaning attributions about blockchain (Bijker, 2012, p. 168). The process underpinning the construction of frames also entails the active opposition to alternative meaning attributions (Benford & Snow, 2000), resulting in polysemic interpretations of the same technological artefact.

In the case of blockchain, its current multistability (Ihde, 1990) echoes the early diffusion stages of social media in 2004 and the Internet in 1994 indicating the technology's development and diffusion is in an early stage of adoption (Rogers,

1983). Like the Internet and social media before, the media play a critical role in shaping blockchain's future.

3.1 Studying controversies through social media

Scholars have shown digital media are a key site to observe the rhetorical and discursive maneuvering and meaning making about new technologies (Marres & Moats, 2015). Social media provide plenty of data for analysis through quali/quantitative methods such as automated/manual content analysis (Lewis, Zamith, & Hermida, 2013) and social network analysis (Himelboim, Smith, Rainie, Shneiderman, & Espina, 2017). Moreover, the availability of metadata-enhanced datasets facilitates researchers in the task of tracking controversies across time and (digital) spaces (P. Chow-White et al., 2018). However, the process of information production and circulation made possible by social media is increasingly complex and articulated. Within this process, sharing news on a social media platform often represents one among many steps involved in the construction and circulation of meaning (Carlson, 2016).

For this reason, we investigate the blockchain debate as it unfolds on Twitter and beyond. We gather data from Twitter as a way to measure the public interest in blockchain over time (Faris, Roberts, Etling, & Benkler, 2016). Instead of focusing exclusively on Twitter data, our analysis extends to the mainstream and specialized news websites constituting the blockchain mediascape. We describe and visualize controversies in the adoption and diffusion of blockchain technology as they develop in social and digital media by conducting a human-coded framing analysis of the most tweeted news stories about blockchain. Our goal is to contribute to our current understanding of social, financial, and technological antecedents and consequences of blockchain adoption and use within society (Crosby, 2016; Underwood, 2016; De Filippi & Loveluck, 2016). Our comparative investigation of discourses in the mainstream and specialized media is guided by the following research questions:

RQ1: How is the meaning of blockchain rhetorically constructed by mainstream and specialized media?

RQ2: What is the general sentiment towards blockchain in mainstream and specialized media?

4 DATA AND METHOD

The sheer amount of data made available by Twitter has recently fostered quantitative analysis in different areas, from studies about digital activism to investigations on public reaction to natural disasters (e.g. Chew & Eysenbach, 2010; Small, 2011). In this research we investigate the evolution of different blockchain discourses promulgated by mainstream and specialized media connecting the Twitter data with the thick qualitative findings emerging from a

framing analysis. Our goal is to demonstrate the possibility to combine the breadth of data-driven approaches with the depth of qualitative, idiographic, methods (Parks, 2014).

4.1 Research Protocol

We conducted a two-stage qualitative analysis of Twitter and the linked news articles (Creswell, 2014, p. 194). We collected tweets containing the hashtag '#blockchain' published between October 2014 and July 2018. The principal investigator and a multidisciplinary team of MA and Ph.D. students developed a Twitter data collection platform (GeNA Miner) in the GeNA Lab at Simon Fraser University. The GeNA Miner collects tweets 24 hours a day 7 days a week via Twitter's Stream API. The '#blockchain' query returned 516,200 tweets at the time of this study, complete with metadata such as username, date, location, tweet type (tweet, retweet, mention, reply) and language.

The first stage of the analysis involved the identification of all the tweets containing links to external resources. Two coders independently and inductively classified the most linked root domains (root domains linked more than 100 times in our dataset, n=136) into thematic categories (Creswell, 2014, p. 198). The final taxonomy is the result of the comparison, discussion and harmonization of the two independent classifications and comprises 11 categories (See Table 1).

Table 1. Website categories

Category	**Description**	**Example**
Forums	Discussion boards for people interested in crypto-technologies	bitcointalk.org cryptocurrencytalk.com forum.lisk.io
Blockchain technology or service	Websites of blockchain products or services. Technologies making use of, or facilitating the use of, blockchain-based technologies.	alpha.wings.ai bitcoinchaser.com bitcoingarden.org
Specialized media	News websites focused exclusively on distributed ledger technologies.	bitcoinagile.com bitcoinist.com bitcoinmagazine.com coindesk.com
E-commerce	E-commerce websites selling hardware, software, courses and other products related to, but not limited to, blockchain.	amazon.com
Mainstream media	Mainstream media news outlets. Both generic and finance specific.	businessinsider.com bloomberg.com fortune.com

Personal website/blog	Personal websites, managed by an individual.	briandcolwell.com sebastienbourguignon.com
Organization	Websites of private companies, either working on the blockchain (e.g. TokenMarket) or not (e.g. PWC)	zrcoin.io pwc.com ibm.com
	Websites of NGO or public organizations either directly working on the blockchain or not	weforum.org
User-Generated Content Platform (UGCP)	Platforms allowing individuals to publish contents (audio, text, video, slides, code, etc.).	reddit.com youtube.com github.com
Social Media	Platforms allowing individuals to create interpersonal relations.	vk.com facebook.com linkedin.com
Technology News Media	Technology-focused news websites.	futurism.com venturebeat.com techcrunch.com
Search Engine	Search engine websites	google.com bing.com

In the second stage of the analysis, we focused on two specific website categories: mainstream media and specialized media. We focused on these two categories as they play two different roles in the creation and circulation of blockchain discourses. Specialized media, as defined in our protocol, publish exclusively and extensively about distributed ledger technologies. They act as sources of information for people familiar with, and often involved in, the development of blockchain technologies. They represent the digital equivalent of printed professional and trade magazines. Mainstream media, instead, address a more general public who might, or might not, be familiar with distributed ledger technologies. Since our goal was to understand how these two types of media framed blockchain technologies, we extracted a stratified random monthly sample (7%) of all the tweets pointing to either a mainstream (n=663) or specialized media article (n=999). This sampling technique, also known as influence-weighted sampling (Faris, Roberts, Etling, & Benkler, 2016), enabled us to build a sample of news that better represents the evolution of the blockchain debate over time than a purely random sample of articles.

Next, a team of three coders analyzed the content of each article and inductively coded them for sentiment, frames, and keywords. Sentiment expresses the general stance that a particular article has with respect to blockchain. We coded sentiment as positive, negative or mixed. Frames express the concepts and the meaning of an article. Researchers identified frames through interpretative thinking, and asking themselves 'What is this article about?' (Strauss & Corbin,

1998). Keywords instead summarize in a succinct way (1 to 5 keywords per article) the content of the article and the specific issues discussed in it (Morse, 2008).

We visually explored the resulting dataset of frames, sentiment, keywords and linked articles using Tableau, which helped us in identifying trends and connections within the data.

5 RESULTS

This section is divided into three parts. In the first part, we discuss the results coming from our analysis of the Twitter dataset in its entirety (n=516,200). In the second part, we analyze the general attitude about blockchain as expressed by mainstream and specialized media. In the third part, we hone in on the socio, economic and technical discourses undergirding such trends and sentiments.

5.1 Blockchain on Twitter

The results of our investigation show a rapid growth in the number of tweets containing the hashtag #blockchain collected by the Twitter miner between October 2014 and July 2018 (Fig. 2). This finding is not surprising considering the many technical advancements, new start-ups, increased users, and the Bitcoin speculative bubble of late 2017 (Vergne & Swain, 2017).

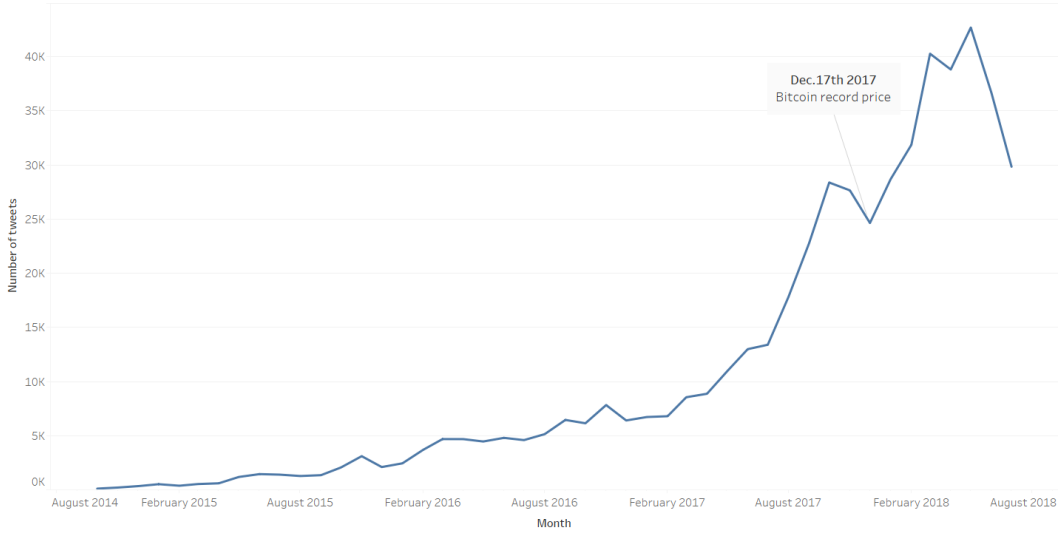

Figure 1 - Number of tweets mentioning '#blockchain', Oct.2014 - Jul.2018

The curve shows a rapid growth starting in January 2017, in the wake of Bitcoin's evaluation which culminated in December of the same year. Interestingly, the blockchain's media coverage continued to grow even after the Bitcoin price dropped in January 2018. As shown in Fig.2, the blockchain media coverage remained well above pre-December levels throughout the first seven months of 2018. However, as explained in the next pages, the Bitcoin crash affected how media talked about blockchain.

5.2 Specialized and mainstream media attitude towards Blockchain

The general attitude towards blockchain is mainly positive in both mainstream (75.2%) and specialized media (79.3%). Analyzing the overall sentiment trend over time it is possible to notice how the positive sentiment has always been dominant, even during periods of crisis, such as after the bubble burst of December 2017.

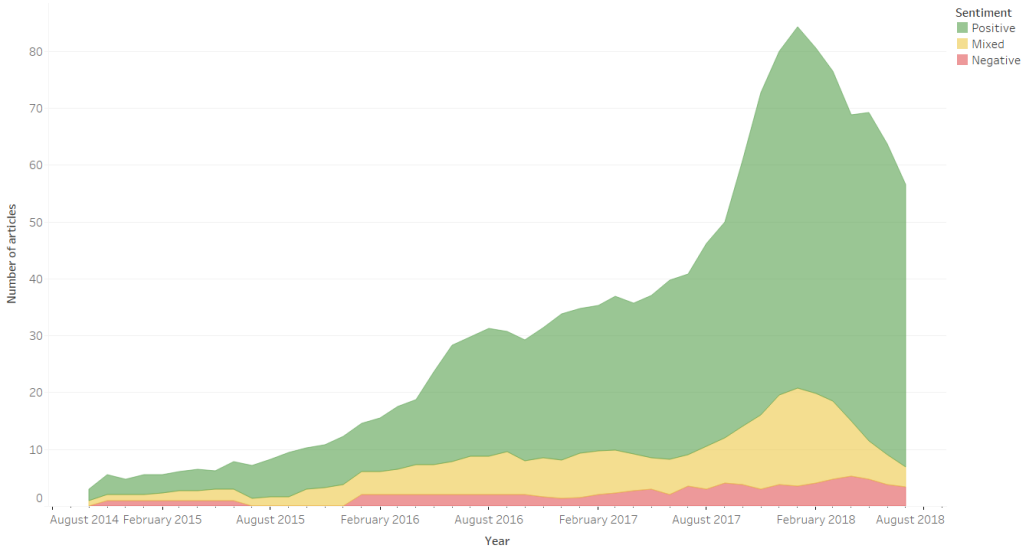

Figure 2. Mainstream and specialized media articles sentiment over time. 3-month moving average from Oct.2014 to Jul.2018.

While specialized and mainstream both display a predominant positive attitude toward blockchain, they show different trends over time. In mainstream media we witnessed a pronounced decline of positive sentiment in the aftermath of the December 2017 Bitcoin bubble-burst (Fig.4).

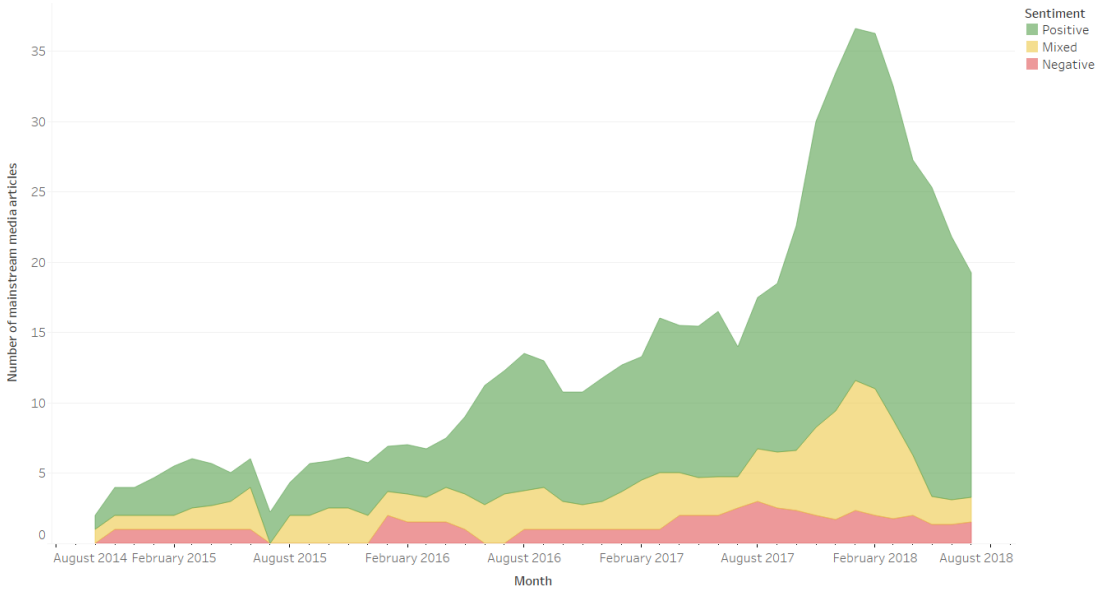

Figure 3. Mainstream media articles sentiment over time. 3-month moving average from Oct.2014 to Jul.2018.

On specialized media, instead, the positive sentiment remained almost constant even after December 2017 (Fig.5).

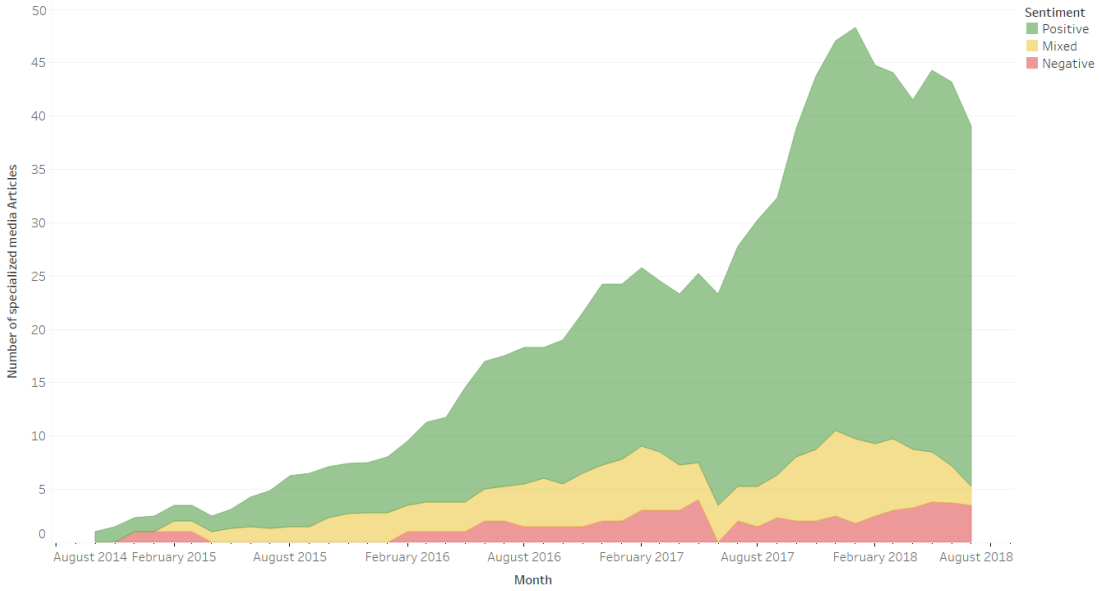

Figure 4. Specialized media articles sentiment over time. 3-month moving average from Oct.2014 to Jul.2018.

In order to address this discrepancy, in the following pages we analyze the discourses constructed and circulated by mainstream and specialized media.

5.3 Media discourses about Blockchain

In this section, we illustrate the qualitative findings of our framing analysis of 1662 articles. The six frames (F1 - F6) that we identified delineate a complex scenario. There are relevant differences in the way the different media frame crypto technologies that we cannot reduce to a boosters-skeptics juxtaposition. Instead, different media envision different futures for blockchain technologies and question their potential in relation to legal, economic, and technical contexts. We summarize these differences in this visual synopsis of mainstream and specialized media frames (Fig.6):

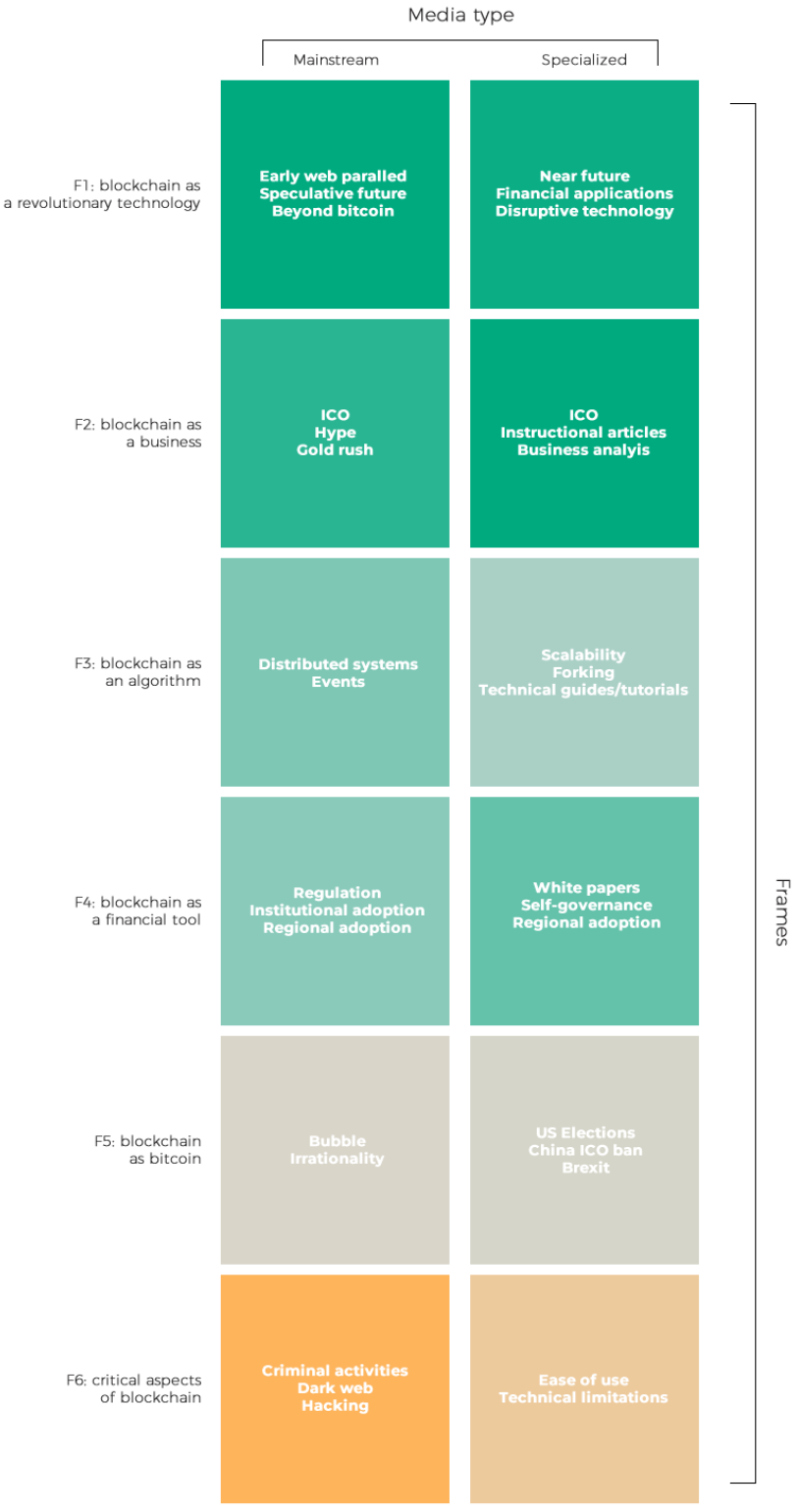

Figure 5. Themes, top keywords and sentiments on mainstream and specialized media. Color ranges from green (positive sentiment) to orange (negative sentiment)

F1: blockchain as a revolutionary technology.

The most salient discourse in mainstream and specialized media is the 'future of blockchain' (24% of the sample in mainstream media and 15% in specialized media). Both media types display a positive attitude with respect to blockchain: 82% positive in mainstream and 92% positive in specialized media. Despite commonalities, the two media types debated the future of this technology in very different terms.

Mainstream media. We found several mainstream articles published between 2014 and 2015 illustrating the Bitcoin-blockchain distinction and framing the latter in contexts other than cryptocurrencies. Mainstream media often described blockchain as an infrastructure and used the Internet/World-Wide-Web distinction as an analogy to explain how blockchain stands with respect to Bitcoin. An example from a 2015 Wired article illustrates the connection:

> Just as the TCP/IP-based internet led to a revolution in the way businesses functioned, the Block Chain protocol [sic] is repeating the same process all over again. Pundits even go so far as to say it is like watching the birth of the internet all over again. (Bheemaiah, 2015)

In 2016 and 2017, the mainstream discussion moved from the Bitcoin-blockchain distinction to future applications of cryptotechnologies. The articles identified the potential impacts the distributed ledger might have in different contexts, such as energy management (Cottrell, 2017), food safety (Bellavitis, 2016) and supply chain management (McKendrick, 2017). The disentanglement of blockchain from Bitcoin progressed in late 2017 and early 2018. In respect to the former, mainstream media wrote extensively about future blockchain applications in combination with AI and the Internet of Things (IoT) (e.g. Andriole, 2017; Mitchell, 2017). Most of these articles were speculative: they did not refer to specific or existing technologies, instead, they only envisaged potential future applications (Green, 2004).

Specialized media. Specialized media discussed blockchain's future widely as well. However, we noticed relevant discrepancies in the kind of futures portrayed by this type of media compared to mainstream accounts. The distinction between Bitcoin and blockchain was almost absent as a topic. Instead, 'revolution' and 'disruption' were the most frequently associated keywords within this frame. Specialized media described the distributed ledger as an oppositional, revolutionary technology rather than an infrastructure.

While mainstream media speculated about blockchain applications across a wide range of fields, specialized media focused mostly on financial applications until 2017. This media type envisaged a near future in which traditional financial institutions are substituted by decentralized technologies developed by fintech start-ups. While the mainstream media was speculative, the specialized media articles described actual projects developed by fintech start-ups in the field of banking (Palmer, 2016) and investments management (Redman, 2016). In 2017 and 2018

we noticed the emergence of the keyword 'interoperability', usually mentioned in articles about formats, protocols and APIs for sharing transactions across ledgers (Suberg, 2018). We also registered an increased skepticism toward over-hyped representation of blockchain technologies popularized by mainstream media (e.g. Meunier, 2017).

F2: blockchain as a business.

This frame collected all news dealing with the start-up ecosystem developing around distributed ledger technologies such as investments rounds, mergers, and acquisitions.

MAINSTREAM MEDIA. ICO was a very popular topic for Mainstream media. Initial Coin Offering (ICO) is a form of crowdfunding used by blockchain start-ups to raise capital. Mainstream articles expressed concern about the 'ICO bubble' but at the same time hyped up the data and dynamics of this form of crowdfunding as opposed to traditional investments. '25 million raised under 15 minutes' was, for instance, the way in which Aragon (a blockchain start-up) made it to the headline of Reuters.com (Chavez-Dreyfuss, 2017). Similarly, Bloomberg compared the 'Token bubble' to the Silicon Valley gold rush of early 2000s: 'In just five days, hundreds of contributors signed up for a piece of what they hope will be the next Silicon Valley unicorn' (Russo, 2017).

SPECIALIZED MEDIA. The term 'ICO' was also very prominent in specialized media. ICO-related articles announced new crowdsales, provided information on how to purchase tokens and analyzed the business models of the debuting start-ups (e.g. Coleman, 2016b; Suberg, 2017b). Interestingly, specialized media articles mentioning ICOs started appearing in 2015, well before the mainstream media started to pick it up in the spring of 2017 (Jenn, 2015; Kastelein, 2016; Wilhelm, 2017). In specialized media, the popularity of ICOs increased significantly in September 2016. This increase in saliency was an effect of notable events such as the post-ICO collapse of the Decentralized Autonomous Organization (DAO) (Vigna, 2016). ICOs relevance was also due to the amount of advertising published in the form of advertorials by specialized media.

We observed a decrease in the salience of ICO in the first months of 2018. Our data does not show the motives behind this decrease. However, two regulatory moves happened in September 2017: China banned ICOs and the US Securities and Exchange Commission (SEC) announced that Initial Coin Offerings may fall within the regulatory scope of federal securities laws (Deng, Huang, & Wu, 2018). Moreover, Google and Facebook banned ICO advertising from their ad-networks in early 2018 (Facebook, 2018; Google, 2018). These events could explain the decline of the 'ICO' hashtag in early 2018 and the emergence of new, alternative, acronyms such as Security Token Offering (STO) and Public Token Sales (PTS) (Sedgwick, 2018).

F3: blockchain as an algorithm.

Another difference was the way in which mainstream and specialized media represented blockchain as a technical, tangible artefact.

Mainstream media. Mainstream media rarely addressed the technical underpinnings of blockchain. Mainstream articles provided broad overviews of the technicalities of blockchain, explaining for instance concepts such as cryptography, decentralization, and security in peer-to-peer networks (e.g. Aitken, 2016). In 2017 and 2018 we noticed a proliferation of articles illustrating the differences between blockchain protocols (e.g. Mavadiya, 2017). It was interesting to notice, at the peak of the Bitcoin bubble, numerous links to articles about the Bitcoin-blockchain difference inviting readers to see the utility of distributed ledger technologies beyond the cryptocurrency hype (e.g. Butts, 2017; Culpan, 2017).

Specialized media. Specialized media often dug into the algorithmic details of the technology. Blockchain was questioned in terms of its technical qualities, as well as its promoted values (e.g. decentralization vs. centralization) and economic potential (e.g. disruption vs. reformation of industries). For instance, we found articles discussing the scalability of blockchain (e.g. Suberg, 2017a) and debating hard forking or splitting chain issues (Van Wirdum, 2017). In 2017, the specialized media attention was catalyzed by 'Bitcoin's greatest protocol update', i.e. the introduction of SegWit, a transaction format aimed at solving Bitcoin's scaling issues (e.g. Lyon, 2017).

These articles guided the readers through the technical details and limitations of algorithms and protocols. They also provided actionable information to those who wanted to learn how to tinker with blockchain technologies. For example, in 2014 Cryptocoin News published a beginner's guide for developing a Bitcoin parser, i.e. a software application for reading the Bitcoin blockchain (Gorale, 2014).

F4: blockchain as a financial tool.

This frame encompasses all the articles that examined blockchain applications in the financial sector. Both media types presented blockchain through two scenarios: 1) a substitute for traditionally used financial tools and 2) an entirely new technology. Articles from both media furthered the theme of blockchain as a technological infrastructure, whose elements can be recombined or substituted for carrying out traditional financial activities (Worstall, 2016). At the same time, both media portrayed blockchain as a technology with a revolutionary potential recognized by major financial players and banking institutions.

Mainstream media. Mainstream media were generally more cautious in predicting the implications of blockchain by mentioning issues of regulation, security, and privacy. Mainstream media emphasized the cautionary 'wait-and-see' approach by government and financial institutions (Narasimhamurthy, 2016) and their preference for using permissioned distributed ledger technologies over public ones (Berke, 2017; Tian, 2017). Moreover, when it came to discussing governance

initiatives led by national and regional institutions (e.g. in Senegal, Chutel, 2016), the sentiment was mainly positive in mainstream articles.

SPECIALIZED MEDIA. Specialized media expressed a more positive sentiment on the alleged disruptive potential of blockchain. Besides traditional articles, this media type also published research reports and white papers (Coleman, 2016a). While acknowledging existing privacy and security issues, specialized media presented blockchain-driven solutions developed by start-ups, such as in relation to illegal trade (Caffyn, 2015) or identity management (Cummings, 2017). We also noticed a predominant 'booster discourse' casting a positive light on those countries leading the blockchain revolution (e.g. Das, 2017). In 2018 specialized media focused on various US initiatives aimed at framing blockchain tokens as securities. The most prominent examples in our dataset were a failed legislative attempt in Colorado (Wood, 2018) and SEC's approval of Coinbase application to list digital coins as securities (Alexandre, 2018).

F5: blockchain as Bitcoin.

Mainstream and specialized media alike followed Bitcoin's daily price rollercoaster. Our data show mainstream and specialized media coverage of Bitcoin intensified exponentially starting in January 2017 and followed closely Bitcoin's price appreciation that peaked at almost $20,000 USD in December 2017. In both media types, the overall sentiment over the 46 months of our investigation was negative. Mainstream media articles tended to emphasize the dangers of Bitcoin in periods of appreciation and rendered a more positive image during periods of depreciation. Moreover, as we have seen in the 'Blockchain as a Revolutionary Technology' frame (F1), mainstream media articles were often of a speculative nature, whereas, specialized media articles paid more attention to the connections between geopolitical events and Bitcoin's value.

MAINSTREAM MEDIA. The Bitcoin issue was very controversial in mainstream media. In 2015, the general attitude was positive, despite the depreciation which hit the cryptocurrency in 2014. In January 2015, Fortune magazine predicted that cryptocurrency would experience 'big momentum' in the following year (Roberts, 2015). Business Insider argued that the 2014 depreciation was good news for Bitcoin, as it was the consequence of a mini-bubble which burst at the end of 2013 when the cryptocurrency hit the then all-time high of $1,240. The post-bubble period should create a new era of reconstruction and solidification of a technology now finally safe from the media hype, the article continued (Frisby, 2015). The positive outlook of mainstream media was quickly overturned by Bitcoin's appreciation which started in mid-2016 and grew exponentially into 2017. From 2016 to 2017, the keywords 'bubble', 'ICO', 'bitcoin cash' and 'hard fork' began to dominate the discourse. These keywords were also accompanied by mostly negative connotations. The press started writing again about the dangers associated with the irrational race to Bitcoin speculation and unsubstantiated faith in cryptocurrencies

(Kelly, 2017). In late 2017 the dominant keywords in our dataset were 'Bubble' and 'Hype'. They were associated with negative sentiment and pointing to articles reporting the daily records of Bitcoin and other cryptocurrencies (e.g. Browne, 2017).

SPECIALIZED MEDIA. Specialized media also covered Bitcoin's price very closely. Articles often associated Bitcoin's price movements to political events. Examples include the impact of China ICO ban (Dhaliwal, 2017a), SEC regulation of Bitcoin ETF (Rizzo, 2017), Trump election (Higgins, 2016) and Brexit vote results (Bovaird, 2017). Interestingly, in the late-2017 Bitcoin bull run, we found articles in our dataset that, appealing to the technology's supposed transparency and mathematical rationality, tried to counter the Bitcoin-bubble discourse promoted by mainstream and specialized media as well (e.g. Young, 2017).

F6: critical aspects of blockchain.

Four percent of the articles on our sample addressed critical aspects of blockchain (mainstream media 5.6% of sample and specialized media 2.7 %). These critical articles provided an important counterbalance in the discussion of crypto technology. As in previous discourses, mainstream and specialized media developed different critiques.

MAINSTREAM MEDIA. Mainstream media often emphasized the criminal applications of blockchain, such as 'dark' web transactions or the distribution of illegal content (Fox-Brewster, 2015), rather than pointing to specific technical problems (Greenberg, 2014). Mainstream articles often criticized cryptocurrencies and especially Bitcoin. The stigma associated with Bitcoin was particularly relevant in 2014 articles when negative events such as the alleged use of bitcoin in money laundering on the Silk Road marketplace prior to 2013 and the hack of the Mt.Gox exchange in 2014 reverberated through the pages of mainstream media websites. We also observed the gradual progress of mainstream media from 2014 onwards to discursively disentangle blockchain from Bitcoin and discuss it as an infrastructure on its own. In some instances, mainstream media articles questioned about the real utility of blockchain technologies, as in a widely circulated 2018 CNBC article asking to ditch trustless technologies and recuperate human trust (Stinchcombe, 2018).

SPECIALIZED MEDIA. Specialized media focused on the technical aspects of blockchain in relation to its possible use cases. For instance, while comparing blockchain's potential to the Internet, one article (Dhaliwal, 2017b) criticized the former for issues of interoperability, governance, and ease of use. Specialized media also published and debated possible solutions to technical problems. For example, a 2016 CoinDesk article criticized the proliferation of blockchain based private applications and their progressive departure from Satoshi Nakamoto's founding principles (Wolinsky, 2016). In 2017 and 2018 the focus moved to ICO-related

problems, such as the risk of frauds and the already mentioned ICO advertising ban from major social media platforms (e.g. Higgins, 2017).

6 DISCUSSION

The results of our investigation show the majority of articles circulating on Twitter about blockchain promoted a positive attitude towards crypto technologies (77.7% positive, 17.7% mixed, 4.6% negative). The findings show the general attitude about blockchain was predominantly positive in both mainstream and specialized media during the time period (RQ2). The discourses developing around distributed ledger technologies are complex and multifaceted and indicate a general transition in the rhetorical definition of blockchain (RQ1). As our framing analysis reveals, the discourses used by mainstream and specialized media to describe blockchain are not necessarily unitarian nor consistent with each other.

Specialized media framed blockchain as a technology capable of revolutionizing the world of finance and to expand beyond it. These websites depicted blockchain as a 'disruptive' technology as well as a business opportunity and an algorithm. Specialized media generates what we call a crypto-deterministic utopia (as found in F2, 'blockchain as Business' frame). This instrumental conception of blockchain promotes and naturalizes the idea that the optimal organization of resources is achievable thanks to the algorithmic rationality of the distributed ledger (Brett, 2014; De Filippi & Loveluck, 2016; Garrod, 2016). Media producers present blockchain as an inherently neutral technology capable of freeing people from oppressive government interventions (Karlstrøm, 2014). However, specialized media also focused on the sociotechnical and political contexts surrounding blockchain. As illustrated in our 'blockchain as a Business' (F2), 'blockchain as Bitcoin' (F5) and 'critical aspects of blockchain' (F6) frames, blockchain technologies are discussed in close connection with national regulatory frameworks and world geopolitical events. The image of blockchain rendered by these articles is of a technology embedded into the socio, technical, and economic fabric (Sassen, 2002). Specialized media also depicted blockchain as an open and participatory technology that everyone can use ('blockchain as an Algorithm', F3). The evolution of blockchain, as promoted by specialized media articles, is therefore less clear-cut than a purely crypto-determinist utopia would argue. Instead it is more prone to social, political, and technical contingencies.

Narratives of blockchain as a revolutionary technology continued on through the pages of mainstream media, although in more metered ways. Mainstream media presented a tamed version of blockchain as a 'flexible technology' whose elements can be re-designed and used to better serve the needs of established institutions. The most relevant findings from our research reveal a rhetorical shift in the meanings associated with blockchain away from the bitcoin stigmatization and towards a conception of the distributed ledger as infrastructure. This shift is evident

in the positive sentiment that characterized the 'blockchain as a Revolutionary Technology' (F1) frame in 2016-2017.

This study faced some limitations. Because of Twitter's commercial strategy, the amount of data freely available via Streaming API is capped at 1% of the entire Twitter stream (Dai, 2013). However, they claim it is a random 1%. Another limitation is due to the fact that we started collecting data from October 2014, when the term blockchain started surfacing on social media. Therefore, our analysis did not consider all the news about distributed ledger technologies circulating on Twitter between October 2009 (when Nakamoto published the Bitcoin white paper) and October 2014. Despite these limitations, we believe that a 46-months longitudinal study is both significant and extremely meaningful, especially in a field in rapid transformation such as blockchain.

7 CONCLUSION

Our analysis shows how a positive conception of blockchain as an 'enabling technology' is substituting the negative connotation deriving from blockchain's past association with Bitcoin. Dubbed as blockchain 2.0 and 3.0 (Swan, 2015), this new characterization of distributed ledger technologies unfolds around the idea of blockchain as an infrastructure (Star, 1999) that institutions can use and integrate into their operations. In contrast, specialized media foster what we have called crypto-deterministic utopias. Although positive, these discourses are also very critical and reflexive about the technical features and limitations of blockchain. Moreover, specialized media are more aware than the mainstream media of the influence that socio-political events can have over the development of this technology. Furthermore, by publishing tutorials and technical guides, specialized media create the conditions for the public to intervene in the actual development of the blockchain and to re-shape it at a technical level.

This inquiry informs communication and STS theory by showing how different media types interact in the process of rhetorical closure. Despite the recent attention of mainstream media towards blockchain, the most popular articles on Twitter come from specialized media. The two media types share the same frames but articulate them differently. The pragmatic, action oriented and participatory discourses of specialized media counteract the speculative narratives promoted by mainstream publications. These interactions between media types further complicate the process of technological stabilization. Twitter, and social media more in general, open the debate about technology to actors who rarely had the possibility to participate in the process of technological definition and diffusion in the past (Chow-White et al., 2018; Rogers, 1983).

We have shown the discourse on blockchain to be a lively site of social interaction and shared meaning-making. This discourse contributes to blockchain global diffusion, which is expanding at a rapid rate and, potentially, disrupting many aspects of economic and social life. The academy is not insulated from these

social changes as evidenced by the burgeoning literature on blockchain across fields. For example, Business has been quick to focus on what could be the third wave of the Internet. Frizzo-Barker et al. (2019) analyzed the first five years of blockchain research in the business field from 2014-2018. They found a richly developing field that was largely in the exploratory and conceptual stage with some empirical studies on economic and organizational impacts. Chow-White et al. (2020) explored blockchain research in the Communication field and found a less developed scholarship. However, the studies focused on critical issues such as social impacts, power and governance, privacy and identity, and healthcare among others. New studies could enhance the already existing research and explore new directions.

The discourses around crypto technologies circulating across specialized and mainstream media appear to be complex, multifaceted, and often not consistent with each other. Communication (e.g. Rogers, 1983), Business (e.g. Green, 2004), and Science and Technology Studies scholars (e.g. Bijker, Hughes, & Pinch, 2012) have explored how discursive dimensions of technological artifacts can impact the diffusion of innovations. This rich line of research argues discourse can have enabling and disabling impacts on the material development of new technologies such as blockchain. Digital research is well-positioned to explore this phenomenon because so much of social life can be captured online nowadays.

Future Direction: Further explore the role of discourse in the innovation and adoption of blockchain among actors and social groups such as practitioners, developers, the public, and decision-makers within and across a range of industries, such as energy, healthcare, supply chain, and fintech.

Digital media represent a rich context for analyzing the discursive dimension of technology, however, they also present significant challenges. Issues of accessibility (Snodgrass & Soon, 2019), data ownership, openness, and control might limit the amount and the quality of data made available by digital platforms for social research (Bucher, 2013). Moreover, an uncritical approach to digital media might lead scholars to further reify a western-centric perspective on innovations and technological diffusion. Therefore, we hope future contributions will investigate the social construction and adoption of blockchain in the Global South, among marginalized groups in the West (e.g. Adams et al., 2019).

Future direction: Investigate the social impact of blockchain in addressing problems and challenges specific to the Global South and among marginalized groups in the West, such as along racialized and gendered lines. Scholarship would be enriched through empirically based studies using qualitative methods (e.g. interviews, case studies, and ethnography) and data-driven quantitative approaches.

One of the major forces that impacts the development of blockchain globally is regulation. Each regulatory context, such as the nation-state, has its own laws and governance. Blockchain developers and users need to navigate these contexts at the state level and, often, at the intra-state level. The mechanisms of governance are formed, in part, through the negotiation of meaning by actors and social groups using discourse. Scholars can capture the evolution of blockchain governance and

contribute their findings constructively to these conversations. Further, scholars can play a critical role in the adoption process by investigating its positive and negative impacts and engaging practitioners, decision-makers, and policymakers.

Future direction: Conduct studies on the relationship between discourse and governance of blockchain at the state and global organizational levels such as the Securities and Exchange Commission in the United States.

One of the topics we found in our study concerns identity and privacy. Privacy has become a critical issue in social science research in the fields of Communication, Law, and Political Science because of the proliferation of individual's information online and the problematic or, sometimes, nefarious use of that information by organizations. Further, privacy is a shifting target in the digital age and difficult to capture in research and governance because of the dynamic nature of new technologies such as social media, big data, and AI. Users and developers view blockchain as an important tool for the management of privacy. We need to know more about how blockchain can be used to protect privacy, which applications are being developed for this purpose, and why.

Future Direction: Investigate the relationship between blockchain and privacy to understand how the technology is being shaped to manage privacy. For example, this research can be case studies of individual ventures, such as privacy coins like Monero and Civic, and/or interactions between blockchain and privacy regulations such as the European General Data Protection Regulation or local regulations such as Personal Information Protection Act in British Columbia, Canada.

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