

Rambunctious Geographies: Intimate Encounters, Algorhythmic, and
Making the Blockchain Real

by

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B.A., University of Calgary, 2008

M.A., University of Victoria, 2013

A Dissertation Submitted in Partial Fulfillment of the Requirements for the
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We acknowledge with respect the Lekwungen peoples on whose traditional territory the university stands and the Songhees, Esquimalt and WSÁNEĆ peoples whose historical relationships with the land continue to this day.

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Abstract

Blockchains, like many “disruptive” digital media, continue to garner significant academic and popular attention about what they *are*. Recent critical provocations in geography and cognate disciplines shift lines of enquiry to interrogate the material realities of digital technologies, emphasizing instead *how* they are lived. Inspired by critical and feminist thinking, the primary task of this dissertation is to follow the latter mode of analysis and present a critical cartography of blockchains, loosely defined. The critical cartography presented in this study sketches a conceptual and methodological map of context-specific and intimate blockchain practices I participated in and experienced from 2013-2020, in a mostly Canadian context. I construct this cartography by using a variety of autobiographical and auto-ethnographic methods that are sometimes buttressed by more conventional qualitative methods. Research reveals that blockchains have the capacity to become economic in a diversity of ways, enacting multiple rowdy characteristics of capitalism, a phenomenon I term rambunctious capitalism. Rambunctious economic flows actualizing through blockchains rely on different situations of power to enact nomadic subjectivities in a variety of spatial, temporal, and material contexts. Specifically, the blockchain practices addressed in this dissertation highlight the embodiment of joyful moments for a pregnant body working in Toronto’s crypto-economy, the *algorhythmic* impacts of blockchain hard fork events, where code participates in the instantiation of diverse temporalities that produce uneven geographies, and the materialization of Canadian policy discourses about blockchains that position and, in some cases, implement these media as smart solutions to civic service delivery. Findings presented throughout this study contribute to feminist and digital geographies by offering autobiographical, auto-ethnographic, and intimate accounts of blockchains, and how they are practiced as lived and multiple realities. In addition, this dissertation also adds ethnographic research to the now expansive multi-disciplinary scholarship on blockchains and cryptocurrencies to understand how these media operate in specific contexts.

Keywords: blockchains; critical cartography; economization; digital geographies; feminist geographies.

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Dedication

هیلدا ، عشق من ، من تو را از زمین تا آسمان دوست دارم

Chapter 1

Introduction

Under capitalism, processes of political subjectivation must both enter and break from economic, social, and political flows. The two operations are indispensable: start from the hold machinic enslavements and social subjections maintain over subjectivity and produce a rupture, which is always at the same time an invention and constitution of the self ... The suspension of the ordinary course of things first of all affects subjectivity and its forms of expression by creating the conditions for new subjectivation. This process must be problematized (Lazzarato, 2014, p. 19-20).

Bitcoin's central and most exciting piece of technology is something called the blockchain. This is a register of all the bitcoin transactions that have ever happened. Every time something is bought or sold using bitcoin – remember, that means every time something moves from one place in the register to somewhere else – the new transaction is added to the blockchain and authenticated by a network of computers. The techniques are cryptographic. It's impossible to fake a new addition to the chain, but it's relatively easy (by relatively easy, I mean relatively easy for a huge assembled array of computing power) to verify a legitimate transaction. So: impossible to fake but simple to verify. The entities transferring the money are anonymous, and at the same time completely transparent: anyone can see the bitcoin addresses involved, but nobody necessarily knows to whom they belong.

This combination of features has extraordinary power. It means that you can trust the blockchain, while knowing nothing about anyone else attached to it. Bitcoin is ... a register that anyone can see and to which everyone assents. For the first time in human history, we have a register that does not need to be underwritten by some form of authority or state power, other than itself – and, as I've argued, that register isn't some glossy add-on to the nature of money, it actually is how money works. A decentralised, anonymous, self-verifying and completely reliable register of this sort is the biggest potential change to the money system since the Medici. It's banking without banks, and money without money (Lanchester, 2016).

This dissertation begins at the intersection of Lazzarato (2014) and Lanchester's (2016) excerpts above to interrogate some of the processes of subjectivation emerging from the 'machinic enslavement' and 'social subjections' associated with blockchains.

Lazzarato (2014) traces the relationship between capitalism and the production of subjectivity through an examination of the 'humans-machines' apparatus to identify and

sustain 'ruptures' that may enable political action (Lazzarato 2014, p. 26). Meanwhile, Lanchester's (2016) investigation of Bitcoin and its blockchain emphasizes how this very apparatus promises to abstract away social processes of trust, thereby opening one of many entrypoints to problematize how, when, and where blockchain 'machines' create and reconfigure the 'conditions for subjectivation' (Lazzarato 2014, p. 20).

According to Lanchester (2016), the blockchain's 'self-verifying' features reveal unforeseen 'extraordinary power.' What does this power involve, and how does it flow? What, for instance, makes digital media such as blockchains, which can be grossly reduced to a distributed peer-to-peer database with additional information security measures, so powerful? Is it that blockchains reconfigure contemporary, Western understandings of finance, effectuating the conditions for, in Lanchester's (2016) words, 'banking without banks, and money without money' to actualize? Or does the blockchain's 'extraordinary power' lie in its supposed ability to accurately represent digitized attributes about ourselves and our environments? Epistemological enquiries like Lanchester's (2016) are prominent in the wider pluri-disciplinary scholarship and mainstream media think pieces on bitcoin, cryptocurrencies, blockchains, and the internet of things, with emerging geographical contributions taking up structural questions about blockchains as the next in an ongoing trends of new media reproducing capitalism through newfangled forms of digital extraction (Calvão and Archer 2021; Zook 2018; Zook and Blankenship 2018). These provocations are instructive for researchers, and geographers specifically, in our collective attempt to understand and diagnose new media in our present moment. My aim, throughout this dissertation, is different. In the chapters that follow, I attempt to think about the multiple realities

blockchain can enact, and where, how, and what kinds of subjectivities emerges through these realities, and create specific geographies.

Dissertation goals and objectives

This dissertation investigates the instantiation of digital economies through an autobiography and ethnography of blockchains. My main task with this text is not to present a definitive and generalized definition of cryptocurrencies (peer-to-peer, unregulated digital entities of cash like bitcoin) or blockchains (the underlying protocols animating cryptocurrencies). Rather, this is a partial and intimate take on an experimental project that is still unfurling – one conceptual, analytical, and methodological block at a time.

The primary goal of this dissertation is to sketch a critical cartography of digital capitalism today through an intimate account of cryptocurrencies and the blockchains that animate them. I set out to accomplish my goal by undertaking three specific objectives:

1. Identify some of the ways blockchains are invoked and used to produce, sustain, or resist the proliferation of digital capitalism, or become economic;
2. Sketch a critical cartography of the micropolitical realities of blockchains, especially as they operate in, through, and around bodies; and,
3. Illustrate the geographies of blockchains through three empirical figurations of their embodiment, temporality, and materiality.

The rest of this chapter comprises a brief discussion about my mode of enquiry, methodology, and an overview of the dissertation.

I anchor the reflections in the dissertation below, based on over six years of research on the topic, onto what many may perceive as an unusual analytical catch. I move away from diagnostic questions that seek to identify the “extraordinary” powers of digital media, such as blockchains, or what they *mean*. The focus of this dissertation is, rather, on the micropolitical realities enacted by blockchain technologies. Or, to put it differently: this dissertation offers a situated sketch of what I observed blockchains doing to certain bodies and under specific conditions. Following Mol (2002, p. 13), this text and the analysis contained in the pages below highlight the ‘practicalities, materialities, *events*’ of blockchains as I’ve encountered and witnessed them. To take another cue from Mol (2002, p.13), this research project offers one account of how blockchains ‘become a part of what is done in practice’ in the economy. My specific focus, then, is to write about the diverse ways that power, in blockchain protocols and implementations, as well as events and encounters relating to these media, operate in restrictive and/or generative ways. Restrictive and generative situations of power become possible because blockchains, I argue, reveal processes of subjectivation and potential subject locations with the capacity to, but that don’t always, become economic in various ways. Simply put: this dissertation interrogates the ways by which blockchains, loosely defined, trigger diverse and different micropolitical processes and how blockchains actualize space, time, and matter in economic ways.

My approach, which I recognize is unconventional, warrants a number of qualifications, especially since, at times, I actively sidestep certain dominant discussions

or debates about capitalism and the economy, identity politics and bodies, digital technologies, and theory. Readers will notice, for instance, that discussions about the economy may feature explicitly in some of the papers that follow and implicitly in others. Similarly, this dissertation is, in large part, about the micropolitics of blockchains and related processes of subjectivation. To some readers, this could indicate that I *should* spend a lot of time talking about identity politics and bodies. I don't really do this because subjects, according to my conceptual scaffolding, are complex and nonunitary, meaning that I'm interested in how subjects are always undergoing change in some way (Braidotti 2013). I am less interested in analysing how different systems of oppression interlock to work together, not because these questions are not important (they certainly are), but because my interest is in momentary and situational flows of power that portend transformation (Combahee River Collective 1977).

Conceptually, this dissertation draws on ideas from feminist political economy and new materialisms, especially the geographical literature in that subfield, to think through some of the ways digital media such as blockchains have the capacity to become economic. Given the association between blockchains and financialization, or software and capitalism, this is by no means a groundbreaking opening position. For example, it is now generally accepted that software is very much alive and laboring in the service of capitalism. In many cases, code becomes capital: software can be programmed to work, accumulate, and circulate wealth, or what economic geographers and political economists call "value." Code has the capacity to create and indeed unite new means of production and productive forces. It is capable of retrofitting analogue forms of capitalism to meet economic conditions made possible by new media.

Digital capitalism isn't incompatible or separate from advanced capitalism. Much like its antecedent, digital capitalism continues to adapt to new conditions of possibility, take over non-capitalist activities in order to accelerate overaccumulation, position and embed capital across new refutations of time and space, and exploit vulnerabilities to dispossess. While I do engage with these and other concepts explicitly in Chapter 2 of this dissertation, feminist political economy concepts and literature are not always foregrounded in every subsequent chapter. Economic questions undergird many of the ideas and analyses presented in Chapters 3, 4, and 5, but they are not always treated explicitly.

Throughout the dissertation, I also forego explicit discussions about what a digital technology is for an engagement with questions about what digitally-mediated and produced methods of communication do, how people use them, and to what empirical effects (Mattern 2017). Digital technologies, Parikka (2010, p. xiv) reminds us, are a means of communication and media 'are not only a technology, a political agenda, or an exclusive human theme'. Media, Parikka (2010, p. xiv) goes on to explain, 'are a contraction of forces of the world into specific resonating milieus' and these milieus operate rhythmically and interact with other political, economic, and environmental relations. I therefore omit an examination of how blockchains are somehow distinct or in opposition to analog or material technologies, recognizing instead that media, including "digital" ones such as blockchains, involve processes of materialization and actualize through the proliferation of language, discourses, representations, and environmental relations. Analysis in this dissertation positions blockchains as material to emphasize

specific ways non-unitary subjects and their bodies get 'caught in a network of power effects mostly induced by technology' and how digitizing/ed capital flows simultaneously 'dematerialize' and harden our social realities (Braidotti 2002, p.17). Because I'm interested in the practicalities of blockchains and questions of subjectification, each subsequent chapter includes a concerted and selective review of the pluri-disciplinary scholarship on blockchains. Some of the research on blockchains I engage with may be from cognate disciplines, while other citations may be more technical.

My interest in blockchains, cryptocurrencies, and other peer-to-peer digital media therefore begins from post-qualitative and process-based modes of analysis that trace situated, embedded, enfolded possibilities and realities of economic actualization. What unfolds in the following pages is a methodological account of blockchains today. My use of today is elastic and spans September 2013 to April 2021, with greater focus placed on empirical events that occurred between 2013 to 2018. A variety of scholarship informs this dissertation, from feminist geography to posthuman feminism and new materialism, select texts from what is widely understood as cultural economy, and a cadre of contemporary scholars writing across critical data studies, internet studies, and media studies.

Monism, the posthuman, and feminist new materialisms

Underlying this study is an attempt to apply a monistic philosophy, following Spinoza, to blockchains (Deleuze 1988). I access monism through the posthuman as Braidotti (2013) defines it and through ideas and concepts prominent in much of what is

generally understood under the category of feminist neo- or new materialisms (Alaimo and Hekman 2008; Barad 2007; Coole and Frost 2010). Monism, as Bennett (2010, p. ix) explains, involves a recognition that 'everything is made of the same substance'. The notion that all is one, so to say, should not be misinterpreted as an outright avowal to a simplistic or 'reductionist' thesis that presumes a single, knowable, defined, and homogeneous ontology (Sheppard and Barnes 2009, p. 573). Rather, a monistic view of the world, in the posthuman or feminist new materialist sense, positions 'substance' as having an 'infinity of attributes' where human and non-human, living and non-living 'creatures', are 'modes of these attributes or modifications of this substance' (Deleuze, 1988, p. 17). Applying monistic thinking, for instance, shifts discussions away from object/subject and nature/culture dualisms that are then upheld in discussions about capitalism and the production of subjectivity. The binary division of objects from subjects, and nature from culture, betrays a 'universal humanism' that equates subjectivity with consciousness and difference, or the Other as 'its negative and specular counterpart' (Braidotti 2013, p. 15). Humanism exalts certain types of consciousness and negates others because, as Braidotti (2013, p.15) puts it, 'we are all humans, but some of us are just more mortal than others'. This rejection of binaries as popularized through Cartesian thinking exposes that, as Deleuze (1988, p. 18) explains, 'what is an action in the mind is necessarily an action in the body as well'. In other words, the body and mind involve different modes of the same substance that animates them, but neither offers superior insights about the worlds we inhabit. Everything is, as a

result, involved in some continuous and evolving process of becoming, of changing, of *materialization*.

Anti- or post-humanism, then, acknowledges that human bodies are different, operate in fuzzy, paradoxical ways to produce knowledge, that this co-production of knowledge produces diverse and contradictory subject positionings and these are entangled with things, processes, and assistive technologies to, for example, become economic. Posthumanism and feminist new materialisms more generally allow geographers to emphasize how things become economic and, by extension, capitalist, while underlining that subjectification involves ongoing and diverse processes of formation, malformation, and reformation.

Feminist new materialisms offer geographers a compelling approach to analyze events, processes, and institutions because they emphasize moments and networks of bodily encounters over purely structural investigations that tend to pit one thing in opposition to another. Oppositional ways of thinking about knowledge and its production place severe limits on the types of questions one poses, especially about emerging media that are changing rapidly as we investigate them. Blockchains, cryptocurrencies, and other forms of digital media are examples of such new media, and a feminist posthuman or new materialist approach emphasizes their vibrancy, or how they might materialize in a diversity of ways.

Data, through its imbrication in cryptocurrency blockchains, are more than mere ontological objects that function as classification schemes and repositories for essentialized phenomena and processes. Rather, digitized data – along with the lines

of code, software, hardware, and the people building, refining, and operating systems – animate, generate, reproduce, interrupt, or sustain life under capitalism today.

Algorithms vibrate with agency, carrying out tasks well beyond what humans intended for them.

Methodology: Auto-methods and an anti-methodological ethnography of the blockchain

Underpinning the theories and methodologies in this dissertation is an acknowledgment that the research process itself is inherently and explicitly political. Drawing upon scholars such as Moss (2002), I begin with the assumption that my research endeavors involve a '(re)politicization of all aspects of the research process' (p. 3). I reject essentialist and objectivist truth claims and instead focus on the complex (and often contradictory) matrices that contort power, knowledge, and context together by interlocking the researcher to her research subjects (Moss 2002). My epistemological and ontological scaffolds are thus tenuous at best as I intend to inspect the knowledge I access, describe, interpret, and synthesize while standing on a fractured, uneven, and shifting platform. I am keenly interested in feminist research practices that make it possible for knowledge to emerge as a contestable concept, but one that we can use to further a political project of uncovering multiple realities.

As I mention above, this dissertation is a methodological account of the micropolitical realities of blockchains. But what does that mean, and what roles do methods and methodologies play in this research project? Inspired by McKittrick (2021, p. 35), methodology and methods in this dissertation are acts of 'rebellion and disobedience'. McKittrick (2021, p. 35) asserts this statement in the context of black

scholarship and ‘radical scholarly praxis’. Readers of this text may rightfully be left wondering about the relevance of McKittrick’s groundbreaking work to this account of blockchains. My use of methods and methodology can be read as a form of scholarly insurgency, where I strive to resist classifying blockchains as a singular reality or phenomenon. Again, McKittrick (2021, p. 35-6) is instructive here, noting that ‘methodology and method make discipline and knowledge about categories’ and how,

disciplines are coded and presented as disconnected from experiential knowledge; experiential knowledge is an expression of data (The objective census numbers factually show that the poor living here experience . . .). Disciplines stack and bifurcate seemingly disconnected categories and geographies; disciplines differentiate, split, and create fictive distances between us.

In an attempt to resist singularizing data and its participation in the production of knowledge throughout this research study, I am inspired by McKittrick (2021) and others (Bennett 2010; Feyerabend 1993; Mol 2002; Nordstrom 2018) to apply a sort of post-qualitative or anti-methodological approach to the research. Anti-methodology does not mean that I abandon any attempt at a research design. In many ways, what I conducted could be loosely called an auto-ethnography, with some chapters dabbling in autobiography and other auto-methods, and where research design is framed as more of a general strategy than some fixed formula to produce specific research outcomes (Butz and Besio 2009; Moss and Besio 2019; Nordstrom 2018). This sort of framing is in many ways tacit in some geographical literature, with Cairns’ (2013, p. 335), for instance, noting that ‘ethnography does not simply “take place”’; rather, researchers

create place through 'a relational process that is ongoing, contested, and enmeshed in networks of power'.

What anti-methodology means, in the context of this study, then, is that I draw upon a range of anarchist, critical and poststructural traditions in order to create a research framework that at once recognizes the limits surrounding what Feyerabend (1993, p. 18) calls a 'fixed method, or of a fixed theory of rationality' while also acknowledging the ethnographer's ability to 'writ[e] the "real" through her own words' (Tsolidis 2008, p. 271; also, see Hart 2004). Specifically, I use a variety of 'creative' or what can be loosely categorized as 'auto-methods' alongside other qualitative research strategies and tools to collect, analyse, and present data (Moss and Besio 2019). The primary approach I used involves what Moss and Besio (2019, p. 314) define as 'auto-methods' as the practice of 'treating one's own story as data', where autobiographically and auto-ethnographically tinged stories can still be 'enmeshed accounts of the everydayness of life, or entry points into examining wider processes, systems, and structures of power'. Auto-methods such as autobiographical writing, for instance, reveal my position and partiality in relation to the research, while also emphasizing some of the ways my position as an insider and outsider became complicated, depending on the context of my interactions, experiences, or data collection (Cairns 2013). Such an approach encourages me to heed Gibson-Graham's (2006) suggestion to act 'as a beginner, refusing to know too much, allowing success to inspire and failure to educate, refusing to extend diagnoses too widely or deeply' (Gibson-Graham 2006, p. 8).

In the papers that follow, I use a combination of autobiographical and auto-ethnographic reflections about my own encounters during the research, and excerpts I wrote in my field journals about my life working with and studying blockchains, as the most prominent data collection, analytical, and dissemination technique. These chunks of text range from deeply personal or intimate to reflective and, in other cases, observational. Initially, I relied on more conventional qualitative methods, such as anonymized semi-structured interviews (I conducted a total of 75 interviews) and purposive sampling ‘on the basis of the researcher’s own judgment’ (Bloor and Wood 2006, p. 154). Interviews were conducted in accordance with a research protocol approved by the University of Victoria’s Human Research Ethics Board. I interviewed a range of blockchain and cryptocurrency enthusiasts and professionals that took place in person, over the phone, or the internet. Interview lengths ranged from thirty minutes to over six hours and I only audio-recorded interviews when granted explicit consent from participants. In line with post-qualitative research approaches, I resisted conventional forms of coding and attempted, instead, to “plug in” interview data into concepts (Jackson and Mazzei 2013). In 2015, I used time sampling methods as needed to consider what times of the day I am most likely to encounter and/or observe participants (Bloor and Wood 2006). Over time, however, my employment in the blockchain and cryptocurrency sectors of Toronto, Ontario, and later immersion in Victoria, British Columbia’s then burgeoning “scenes”, afforded me access to a variety of events, people, and information about blockchains and cryptocurrency. I discuss my position as an outsider-turned-insider in Chapters 3, 4, and 5.

In addition, at the beginning of my fieldwork, I collected “found” forms of data (O’Reilly 2005), such as images, infographics, news articles, white and yellow papers, blogs, audio/visual sites, wikis, social networking sites, and content aggregating sites. I used in-person and online interviewing techniques and attended information meetups on blockchains and cryptocurrencies as well as conferences according to schedules of events (Kozinets 2010; O’Reilly 2005). My attendance at in-person meet ups and conferences, as well as my overt participation in cryptocurrency-related discussions as both a mod (moderator) and user of relevant subreddits, listservs, and other online platforms implicate me as a contributor to the cryptocurrency communities, events, and debates (O’Reilly 2005).

The diversity of conventional and more experimental research strategies demonstrates some of the challenges associated with anti-methodology. Anti-methodology is a practice that I aspired to maintain. Still, on many occasions during data collection and in my subsequent analysis, I succumb to the ‘old habits of humanism’ by relying on more conventional methodological techniques (cf. Nordstrom 2018, p. 220; see also MacLure 2013, p. 666). This becomes particularly evident in Chapters 4 and 5, where the publication format and, in some cases, peer-reviewers demanded more conventional discussion of my “results”.

While I didn’t always succeed in resisting interpretivism and meaning-making, anti-methodology serves as a reminder (one that I sometimes forget in the pages below) that producing knowledge *of or about* blockchains in a generalizable manner limits what questions we pose as researchers, analysis itself, and the knowledge outputs created. To be clear, all research approaches limit the focus of inquiry in some way. Yet, my

interest isn't to produce research that positions blockchains as 'objects that precede the knowledge' but to appreciate that 'knowledge is primarily about partaking *in* a reality' (Mol 2002, p.154). Anti-methodology helps me think through agentic qualities of data, or how they 'move together' towards knowledge production (Nordstrom 2018, p. 218).

Organization of the dissertation

This dissertation is organized in six chapters. This chapter and the conclusion, Chapter 6, serve as bookends. The rest of the text consists of a series of stand-alone papers that engage with micropolitical realities of blockchains in some geographical way.

Chapter 2, Rambunctious capitalism: Critical cartography, becoming nomad, and the blockchain remains unsubmitted to any journal at the time of writing and offers a conceptual cut about the economization of blockchains (Sotoudehnia 2021a). The paper is unconventional in its format. In it, I propose a critical cartography as a way to engage with a variety of feminist and new materialist concepts relating to subjectivation and economization, while also including empirical excerpts as analytical devices.

Chapter 2 also sets out some of the concepts framing the dissertation. As I note above, I don't always return to these concepts explicitly later in the text. I draw on process-based ontologies, or what is often taken up through Deleuzian descriptors like "becoming" to trace out some of the ways blockchains reveal our historical situations amidst a "digital capitalism", and how these histories, or as Braidotti (2002, p.13) describes them, 'embodying accounts of one's power relations', involve non-linear, contradictory, and often incomplete transformations (Deleuze and Guattari 1987). Blockchains, I argue, exemplify a rambunctious characteristic of capitalism that relies on micropolitical mutations. These mutations result in a diversity of irregular capital flows

and subject locations that are always undergoing processes of transformation in the service of capitalism and/or its alternatives.

Chapter 3, Sticky waddling: An autobiography of pregnant embodiment in Toronto's crypto-economy, is a reprint of an article published in *GeoHumanities* (Sotoudehnia 2019). In this article, I discuss the concept of space and, more specifically, pregnant embodiment, through a micropolitical examination of my employment at a blockchain startup. Autobiographical reflections about the everyday encounters of a pregnant woman (me) working in Toronto's crypto-economy reveal the analytical potential of emotions. I operationalize rambunctious capitalism without dealing with the term explicitly to offer situated, embodied reflections of my own mutating body in the field. Field journals enable me to expose some of the complicated power relations that impacted my navigation of the nascent blockchain sector of Toronto, Ontario, in 2016 as a pregnant employee of a blockchain and cryptocurrency consulting startup. By fictionalizing some of the details surrounding the encounters I present, I sketch out some of the material realities of what it's like to live day-to-day in the blockchain industry as someone whose body is/was markedly different.

Chapter 4, Algorhythms of a blockchain hard fork is currently under review in the journal, *ACME*, and considers the algorhythms, or multiple spatio-temporal rhythms, of a specific blockchain event: the 2016 Ethereum hard fork (Sotoudehnia 2021b). In this text, I draw on a combination of auto-methods and conventional qualitative methods to interrogate some of the algorithmic temporalities and economic impacts of blockchains. Blockchain algorhythms, to take up Miyazaki's (2012) concept, create multiple temporal possibilities for crypto-capital to materialize. Hard forks of blockchain protocols, which

involve splitting one blockchain into two, forward-incompatible versions of the network, as evidenced by the 2016 Decentralized Autonomous Organization (DAO) exploit on Ethereum's network, lead to the acceleration, deceleration, duplication, or loss of digital time, impacting capital and creating uneven geographies.

Chapter 5, 'Making blockchain real': Regulatory discourses of blockchains as a smart, civic service, is a reprint of an article published in *Regional Studies* (Sotoudehnia 2021c). In the article, I examine some of the regulatory discourses surrounding blockchain adoption and evangelism to understand processes of materialization, or how Canadian policymakers are making blockchain "real". Using excerpts from interviews and informal encounters with a variety of anonymized developers, entrepreneurs, and regulators, I underline some of the ways discourses of blockchain come to matter and, moreover, how the hype surrounding uncritical and universalizing adoption of blockchains-as-a-civic-service recast smart policies for a "disruptive" era of technology. Emerging interest by regulators and policymakers to promote blockchains-as-a-civic-service illustrate some of the contradictions of digital capitalism, where data targeted for entry onto imagined and real blockchains function as a discourse of capital. The results of the blockchain discourses, I argue, are variable.

The dissertation ends with *Chapter 6: Conclusion*. Here, I recapitulate the main contributions of the study, address some of the more glaring limitations of the dissertation and research, and propose future lines of enquiry.

Conclusion

This dissertation contributes to current feminist digital geographical discussions that intend to move inquiry away from dialectical and top-down theorizations of the "digital"

to emphasize instead the empirical and material realities of blockchains (Leszczynski 2020). By presenting a critical cartography of blockchain practices as I experienced and witnessed them in a largely Canadian context and since 2013, I reveal some of the geographical realities enacted through blockchain practices that demonstrate their contingencies and multiplicities. Throughout the papers, I attend to the micropolitical realities of blockchain practices to understand some of the spatial, temporal, and material implications. Specifically, I propose that blockchains, and the ways I experienced and practiced them over the course of the research for this dissertation, reveal rambunctious flows of capitalism, where power operates as a situation that can create diverse economic conditions of possibility for nomadic subjectivities to emerge. I provide an autobiographical account of pregnant embodiment in the Toronto crypto-economy. I also examine the algorithms, or algorithmically produced temporalities, of specific blockchain events, such as the 2016 Ethereum hard fork. In addition, I illustrate some of the ways discourses about blockchains and their promise to serve as a smart technology used to deliver civic services become material in Canadian policy contexts.

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Chapter 2

Rambunctious capitalism: Critical cartography, becoming nomad, and the blockchain

Abstract

This article contributes to discussions about digital economies through a micropolitical examination of blockchains. Specifically, I argue that blockchains involve a set of practices that enact what I call rambunctious capitalism. Rambunctious capitalism involves specific practices that enact obstreperous characteristics of economization: capital can at once accumulate towards crisis and dispossession to create the conditions for joyful subject locations to emerge. Blockchains are data structures used to record and encrypt transactions by distinct peers contributing resources to a distributed network. Each blockchain event, including the transmission of data across the network, the validation and recording of that data transaction to a log, the reading of that log, and the contents of the transaction committed to the log involves a set of practices that create data and the digitized conditions for nomadic or nonunitary subjects to emerge. These blockchain practices are ensconced in power relations and historical moments, enabling subjects to become economic in a variety of ways and creating pathways for capital to circulate. Accessing blockchain-generated subjects through embodied encounters reveals contradictory power relations that impact class, work, and the accumulation of capital. The circulation of capital permits the exploitation of labor and the fixing of assets, all the while complicating what, how, and which bodies get to shape, work, and use blockchains. But capital's lines of flight do not always stick to defined and well-trodden routes. Instead, blockchains initiate multiple and sundry trajectories as they exemplify how, where, and when capital has the capacity to swoop in inchoate and unanticipated ways. *Rambunctious capitalism* captures this unruly set of arcs and trails that disclose the minor

geographies for mutating subjects traversing new digital terrains towards economic difference. In this article, I follow three flows of rambunctious capitalism to sketch out how it operates to reconstitute class, labor, and work. These economic stories of rowdiness contribute to a minor geography of feminist political economy and new materialisms.

Keywords: becoming, blockchains, capitalism, embodiment, minor geographies

Introduction

Blockchains are distributed data structures used to record and encrypt transactions. Distinct peers, or humans directing computers (e.g., Graphics Processing Units and Application Specific Integrated Circuits), contribute resources to run a network without a coordinating authority. These computers work together to verify and log each exchange of information, transmitting data from one machine to another, or peer-to-peer.

Transactions are the most fundamental means through which blockchains are enacted. A transaction begins when someone keys information into the network to transmit specific data. Once initiated, a transaction is batched with others and then broadcast to the majority of network participants until one peer verifies the transaction (Antanopolous 2015). The verifying peer usually receives digital tokens as a reward for authenticating the transaction and contributing to network security. Authenticated transactions are recorded to the blockchain and confirmed by the verification of subsequent blocks of transactions. Eventually, confirmations canonize the transaction as an immutable historical event of the blockchain. Once written to the blockchain's ledger, a transaction can only be revoked by majority decision or if a malicious actor takes control of over 50% of network resources.

Blockchain transactions can create data, tokens, and a ledger. The ledger preserves all historical transaction information while also producing and circulating the resulting data and tokens. By creating, expressing, and recording network activities, transactions enact the ruleset of the blockchain's protocol, determining which data, tokens, and histories are enacted, how, by whom, and when.

In addition to creating, distributing, and recording data transmitted across a network, blockchain transactions involve the creation of currency, the transfer of funds, and the circulation of capital, with digital tokens functioning as a speculative financial asset and medium of exchange. These digital tokens, in turn, circulate as cryptocurrencies (e.g., bitcoin) or non-fungible tokens (NFTs) (e.g., cryptokitties) with the capacity to become economic in different ways. Cryptocurrencies and NFTs, for instance, are used as collectibles, financial assets, stores of value, digital money, and property. Meanwhile, a diversity of private and permissioned blockchain implementations, often categorized as distributed ledger technologies (DLTs), leverage the functionality of an auditable and distributed log of network events without any tokenizing features to increase and streamline datafication, optimize the production, management, supposed privacy and transparency of big data through encryption, and facilitate the digitized economization of data via extractive measures (Calvão and Archer 2021; Mattern 2020).

The economization of a blockchain transaction warrants further consideration. A Marxist perspective, for instance, might breakdown the transaction into its various components to understand the production process. Each step of the transaction is comparable to what Marx (1978, p. 133) described as industrial capital where 'every

branch of production ... is pursued on a capitalist basis'. The creation and transmission of the transaction to other nodes, mining activity verifying the transaction and generating a token as reward for this work, the transaction's eventual hash and entry onto the ledger, and its eventual use as an economic object are all oriented to the generation of capital. The 'actual instruments of labour (e.g., machines)', as Marx (1978, p. 133) might call them. In this case, the computers creating the conditions for the transaction to occur function as a form of constant capital and impel 'value to the product only bit by bit' (Marx 1978, p. 133).

Mining, in Marxist terms, serves a different function. It is a source of variable capital. On a blockchain, mining involves computation committed to the network to authenticate the legitimacy of a transaction and secure the network. Yet, mining cannot occur without labor-power applied to the production of hardware and software required for the blockchain to come into being and persist. Mining also enables 'that part of the capital that produces surplus-value' through the creation of ledgers that track the transfer of data across the network and tokens, both of which can become a source of capital in some way (Marx 1978, p. 140; Sadowski 2019). The production of tokens through mining activities can be considered what Marx would call money capital, or a representation of 'capital value in the state or form of money' (Marx 1978, p.112; see also Harvey 2014).

In contrast to a Marxist reading, a cultural approach, for example, exemplified by Hardt and Negri (2009, 2017), might shift inquiry of a blockchain transaction to scrutinize the mutability of Marxist categories such as constant, variable, and money capital. Rather than diagnosing or quantifying which components of a blockchain

transaction demonstrate capital production, cultural economists might interrogate the very construction and palpability of capital in its various forms (Anderson et al. 2019; see also Gibson and Kong 2005). Such perspectives expose biopolitical and subjective realities associated with the production, distribution, and use of constant and variable capital, such as mining machines, as well as the “immaterial labor”, and creative or “cognitive capital” associated with the development and forking of software used to create and modify rules surrounding transactions (Hardt and Negri 2000; Moulier-Boutang 2011). Cultural economists may also explore the capitalist conditions and post-capitalist futures under which participants or nodes work to propagate, verify, and record transactions. A cultural economic analysis also extends to analyses of cryptocurrencies like bitcoin, which may be understood as cultural artifacts less akin to Marxist definitions of money capital and resembling, instead, a property form of ‘floating, liquid money’ (Hardt and Negri 2017, p. 187).

Both approaches share similar political questions surrounding the economization of blockchain protocols, and its implications for capitalism or any of its alternatives. Marxist understandings of a blockchain transaction, for example, may draw attention to the ways in which code participates in the production of unforeseen monetary forms that eventually produce localized but systemic crises of overaccumulation, all the while reproducing the many contradictions of capitalism (Harvey 2014; Zook and Blankenship 2018). A Marxist framing could also reveal the instantiation of new spaces for capital to accumulate through the deployment and use of protocol-generated digital tokens, compressing time and space while enabling fixes or crises to occur differently, while

also exposing the blockchain's ability to oppress and dispossess anew (Harvey 2014; Zook and Blankenship 2018).

Meanwhile, cultural economists may inquire into the ways people work and live with blockchains, how they experience them, and whether distributed protocols, networks, and their effects incite commoning opportunities or enable the proliferation of new "petty producers" (Arvidsson 2019). Many cultural readings of the economy continue to focus on the systemic effects of digital media like blockchains, but with a targeted emphasis on the cultural impacts of these protocols (Christophers, Leyshon, and Mann 2017). Cultural approaches, for instance, seek to make the boundaries between production, circulation, and consumption indistinct while organizing inquiries around culture, or, in this case, the cultural contexts of a blockchain transaction, as a system or effect of the economy (Anderson et al. 2019; Gibson and Kong, 2005). Culturally inclined scholars may also concentrate analyses on the blockchain transaction as it relates to creative or cultural industries and as a means to investigate capitalist processes subsuming cultural events, phenomena, and artefacts (Adorno and Horkheimer, 1977; see also Gibson and Kong, 2005; McRobbie 2016). While the contours of both framings bind analysis of the same blockchain transaction event differently, a traditional Marxist and cultural economy perspective both expose the blockchain as a transactional log, or an embodied memory, of the spatio-temporal logics of capitalism.

Geographers tend to study spatio-temporal logics of capitalism in the hopes of gleaning broader insights about the ways capital reproduces itself, and how to dismantle it (Harvey 1996, 2001, 2014; Gibson-Graham 1996, 2008; Smith 1984; Springer 2016a,

2016b). The majority of geographical provocations draw upon Marx's (1976, 1978, 1981) corpus through Harvey (1984, 1973, 1996, 2001, 2014), who is largely responsible for introducing and solidifying Marxist thinking as the dominant conceptual framework for most geographers interested in questions surrounding political economy. Scholars, such as Neil Smith (1984) and others (Mann 2013), uphold the prevalence of Marxian thought in geographical inquiry, revealing a persisting interest in structural or class-based analyses of capitalism. Despite the prominence of Marxism in geography, recent disciplinary engagements with political economy highlight the cultural and social aspects of capital, with a surge of interest in cultural economy, economic sociology, and science and technology studies (STS) (Anderson et al. 2019; Christophers, Leyshon, and Mann 2017; Cockayne 2016).

Critiques of these economistic and “culturalized” or culturally inflected’ (Christophers, Leyshon, and Mann 2017, p. 11: see also Sum and Jessop 2013) readings of capitalism give rise to competing interpretations of *how* capitalism works, with a tranche of these studies interrogating the construction, materialities, and relations of markets and the economy (Callon 1998; Christophers 2014a, 2014b). Such interventions analyse the enactment of markets and, by extension, the economy, positing that both are brought into being through various and sustained practices.

Meanwhile, a selection of feminist geographical provocations seek, among other aims, to decentre capital-centric discourses, arguing that dominant representations of capitalism are universalizing and impoverish a collective ability to envision any hopeful, non-capitalist alternatives (Gibson-Graham 1996). Feminist political economists such as Gibson-Graham (1996, p. 21) propose theories of economic difference aimed at

imagining a 'noncapitalist economic imaginary'. Through this feminist project of economic difference, Gibson-Graham (1996) and others perforate the hermetic seals of categories such as production and work, while often foregrounding bodies and "Other" subject locations (Gibson-Graham 2008; Richardson 2018). As expressions of a minor or non-dominant geography of political economy, feminist analyses continue to be overlooked, dismissed out-of-hand, or reduced to a single, more "palatable" work by the majority of the discipline. As a field of study, any in-roads made by feminists are closed off, for as Falconer Al-Hindi and Moss (2008, p. 252, original emphasis) exclaimed over a decade ago, these analyses constitute 'a minor literature produced by minoritarian subjects. The majority do not listen to us or read our work *because they do not have to.*'

In spite of the persisting marginality of feminist economic geographic approaches, these are the conceptual terrains I work from, through, and around to interrogate blockchains as economizing media. The primary task of this article is therefore to chart a minoritarian feminist political economy by examining the 'micro-physical' and 'micro-political' relations of power that arise from various blockchain discourses, protocols, and implementations (Lazzarato 2014, p. 15; see also Oksala 2016). Feminist thought offers useful concepts and ideas to think through flows of power and processes of subjectification involving blockchain technologies. New materialist concepts, in particular, offer insights into the use and wider impact of blockchain technologies on different bodies with implications for digital economies in general. Power becomes evident through various economizing practices implicating blockchains. Practices, moments, and events that involve blockchains unveil situations of power that

either restrict or empower subjects to emerge in winding, chaotic, and exuberant ways, or what I term rambunctious capitalism.

Rambunctious capitalism attends to the variable, emergent, and sometimes contradictory ways that blockchains can actualize diverse modes of economization. This characteristic of capitalism is by no means a novel proposition nor does it have to be confined to digital objects or even blockchains, specifically. Capitalism has arguably always been rambunctious in that it is contradictory, re-engineered continuously, and unstable (Harvey 2014). Yet, blockchains are but one set of novel digital media that intensify capitalism's volatility and have the potential to expose economic difference. This study could, for instance, frame analysis to investigate how blockchains participate in large-scale or systemic modes of economization, and what that *means* for capitalism writ large, or exemplifying as Harvey (2014, p. xiii) might, how digital media lead to 'an increasingly consolidated plutocratic capitalist class ... unchallenged in its ability to dominate the world without constraint' (Harvey 2014, p. xiii). Such an approach may generate insights about what blockchains *are*, but it limits analysis about what blockchains can *do*. Instead, and following Mol (2002), my focus is to highlight the material realities of everyday life with blockchains to sketch an initial understanding of how blockchains become 'a part of what is done in practice' (p. 13). The "what", in the context of this research, can be the economy or what most readers would define as capitalism. To understand how blockchains become a practiced part of wider processes of economization, I scope my examination down to the micro, or bodily, scale.

The "micro" I invoke takes inspiration from Foucault, Deleuze, and feminists writers like Rosi Braidotti, Clare Colebrook, Pamela Moss, and others that recognize

power as capillary, diffuse, productive, relational, and embodied through quotidian habits and practices (Oksala 2016). I therefore create a critical cartography after Braidotti (2013) that emphasizes the bodily politics of capitalism and the micro-physics of power. I begin the article with a primer on how feminist approaches, particularly new materialist feminisms, frame the production of a nonunitary and nonlinear subjectivity through two central ideas in the literature: *becoming* and *nomadism*. I then link both concepts to the idea that blockchains create a rambunctious capitalism. Rambunctious capitalism can be summarized as an animated, inchoate, and open-ended dynamic of capitalism characterized by diverse processes of economization that materialize through flows of generative and/or restrictive forces, or power, and that produce nonunitary subjectivities. A micropolitical analysis of blockchain technologies presented through empirical stories of economic rowdiness reveals the flows of these rambunctious dynamics and how they relate to class, labor, and work. Blockchains create exuberant and unruly lines of flight for nomadic subjects to actualize, revealing some of the ways subjectification is embedded within multiple processes of capitalism, and where those processes incite economic difference. I conclude the article by linking rambunctious capitalism to blockchains through three geographical concepts: across space (embodiment), time (memory), and matter (discourse). The papers presented in chapters 3, 4, and 5 of this dissertation take up the micropolitical questions about blockchains and economization in various implicit ways, and in relation to each geographical concept of space, time, and matter.

A critical cartography of political economy via feminist new materialisms

Cartography is generally associated with map-making in geography. McKittrick (2006, p. xii) associates this particular type of cartography with a 'traditional geography', or dominant geographical articulations 'that assume we can view, assess, and ethically organize the world from a stable (white, patriarchal, Eurocentric, heterosexual, classed) vantage point'. In recent years, critical cartography scholarship emerged to interrogate and indeed reveal the politics of mapping practices and proliferation of new mapping methodologies that can yield spatial insights into power relations (Crampton and Krygier 2006; see also Del Casino and Hanna 2005; Fielder, Schuurman, and Hyndman 2005; and Johnson, Louis, and Pramono 2005).

Feminist new materialists, such as Rosi Braidotti (2002; see also Braidotti 1994, 2011, 2013), take up the notion of a critical cartography beyond conventional and critical geographical interpretations to articulate instead a 'theoretically-based and politically-informed reading of the present'. Inspired by Braidotti, I use critical cartography as a methodological tool to surface and scrutinize the 'process of power relations' and to 'assess the impact of material and discursive conditions upon our embodied and embedded subjectivity' (Braidotti 2011, p. 4). Emphasizing embodiment and its political contexts moves investigations beyond the study and visual representation of discrete objects and subjects on a predetermined political map towards an inquiry focused on identifying a 'cluster of interconnected problems touching the structure of subjectivity' (Braidotti 2011, p. 121). My cartography, while perhaps unorthodox to many geographers, contains certain guiding attributes: it is an *a posteriori* depiction of events that is sometimes autobiographical, sometimes auto-ethnographic, open to redrafting,

and that seeks to describe the complexity, layers, and variable structures of blockchain subjectivities (Bradotti 1994). Or, as Braidotti (1994, p. 6) puts it: 'it is a retrospective map of the places I have been' during this research project.

Despite a longstanding interest in embodied questions relating to space and gender, self-reflexivity and positionality, and situated knowledges (Longhurst 2008; Laliberté and Bain 2018; McKittrick 2006), critical cartographies like Braidotti's (2002; 2005; 2011) are not always identified as a central project for feminist geographers. This, however, does not suggest that feminist geographers do not emphasize what Braidotti (2005, p. 176) calls the 'micro-geography of power relations'. Feminist geographers have long considered the relationships between power, bodies, space, place, time, and matter to investigate everything from the culture of capitalism in financial sectors (McDowell 1997) to black (McKittrick 2006) and pregnant (Longhurst 1994) bodies to the materialities of queer time (Andrucki 2018), critical self-reflection, collective biography, and auto-methods, to identify but a few (Moss and Besio 2019; Laliberté and Bain 2018). These micro-investigations or critical cartographies are often rooted in place, emphasizing the material realities, situated knowledges, and naturalization or 'displacement of difference' that work upon a multitude of bodies and positionings (cf. McKittrick 2006, p. xv; see also Gilmore 2002, p.16; Rose 1997). Critical cartographies therefore begin with an acknowledgement that any interrogation of epistemic conditions and ontological realities will yield partial and incomplete answers, by design. For McKittrick (2006, p. 2), 'Being materially situated in place is an inconclusive process ... [and] holds in it possibilities that do not neatly replicate or privilege traditional geographic patterns of geometry, progress, cartography, and conquest'.

Others, such as Moss et al. (2018, p. 55), draw on Braidotti's work to highlight the need for cartographic inquiries that interrogate 'the generation of embodied subjectivities, that is, scrutinizing the process of becoming'. Cartography as method can therefore help figure space and time differently to highlight where, when, and how power operates to shape our subject-positionings (Braidotti 2013; see also, Moss et al. 2018). Braidotti (2013) reminds us, however, that a critical cartography must also account for the processes that allow for power to emerge in particular locations and structure subject positions. Becoming and nomadism both offer useful framings to better understand processes that make power work to map a given subject, while acknowledging that the production of subjectivity is not a linear process and that subjects themselves are not fixed identities (Moss et al. 2018).

Becoming nomad

Gilles Deleuze and Felix Guattari's concept of becoming, Colebrook (2002b, p.xv, original emphasis) explains, begins with the idea that all life,

becomes or produces relations. It is not as though there are bodies or things that are then ordered through power relations. Nor is there a general system of relations, such as language or culture, which produces different beings. What something *is* is its flow of desire, and such forces produce diverging and multiple relations.

Becoming does away with the assumption that existence or being – that is, action and consciousness – is grounded in some foundational reality. The concept of becoming departs from constructing subjects as fixed (e.g., man) or as “knowers” reacting to events happening to them (Colebrook 2002a; see also Berardi 2009, 2011). The

production of subjectivity is entangled in life itself, which involves a continuous transformation, or 'constant proliferation of questions producing ever more complex series of further problems' (Colebrook 2002b, p. xxxv).

The emphasis by Deleuze and Guattari (1983) and subsequent feminist scholars that life involves an ongoing and chaotic process of transformation, or becoming, rather than the *a priori* existence of a "rational" being coded by a stable essence or reality, demonstrates a philosophical departure from humanist approaches that rely on binaries, dialectical argumentation, and objectivity to frame discussions about subjectivity and identity. Becoming eschews Platonic framings that ascribe an origin to an identity or presume a pre-existing subject that undergoes something happening to them. Instead, the notion of becoming encourages lines of enquiry about existence and identity to recognize being as a process that is always already changing, unstable, and transforming into something else. As Colebrook (2002a, p. 125) states, the concept of becoming presupposes that 'all "beings" are relatively stable moments in a flow'. Notably, becoming does not result in an unchanging outcome or identity because identity is not pre-determined by social relations. Rather, as Colebrook (2002b) notes, 'a body becomes what it is only through these relations' (p. xvi).

The idea that subjects emerge through an unfolding set of processes invites different ways of conceptualizing subjectivity. Some feminists build upon the notion of becoming to explain how subjectification can involve a sort of nomadism, an embodied 'expression of a nonunitary vision of the subject' that is constantly changing (Braidotti 2011, p. 3). Nomadic theory proposes that, since being involves ongoing transformation, bodies take up multiple identities through a diversity of actions and events (Braidotti

1994; Colebrook 2002a). These identities, however, are never permanent, resulting in what Braidotti (2002, p. 12) calls 'a subject-in-process' (see also Braidotti 2010, 2011). For Braidotti (2011), nomadic subjects draw attention to the ways movement of thought and the activation of a positive difference participate in the production of a dispersed, multilayered and complicated subject. The nomadic subject, then, inhabits positions and locations of identification momentarily, contradictorily, and all the while withstanding any potential takeover by dominant and 'socially coded modes of thought and behaviour' (Braidotti 1994, p. 5).

This resistance by nomadic thought and subjects to a "master code" is further illustrative of another Deleuzian concept that circulates among feminist new materialists: minor/minoritarian (Colebrook 2002b; see also Deleuze and Guattari 1983). Nomadic subjects often take up non-dominant or minor positionings that comprise 'subversive moves of detachment from the dominant system of representation' (Braidotti 2011, p. 7). Minor or minoritarian, in this context, does not merely refer to a quantified minority. Instead, minor subjects inhabit locations at the margins, inciting 'active counter-actualization' against a majority position, or 'current state of affairs' (cf. Braidotti 2011, p. 31; see also Boundas 2007, p. 187).

Nomadism, in feminist new materialist traditions, constructs questions of subjectification around a 'positive notion of desire as an ontological force of becoming' (Braidotti 2011, p. 2). By "positive", Braidotti does not mean good or happy. Rather, the positive in nomadic discourses implies the presence of matter actualizing through expressions of self (Braidotti 2011; Duffy 2010). What Braidotti and other feminist new materialists emphasize is therefore not a form of "positive thinking" as Moss et al.

(2018) put it. Affirmation and positivity, in a Braidottian and, by extension, Spinozist sense, indexes desire as an animation and actualization of power as it operates on a body in a particular way, offering insights into how a subject becomes, not necessarily how it *feels*. Power flows as relations that can be restrictive (*potestas*) or generative (*potentia*) (Moss et al. 2018; see also Braidotti 2011). Nomadic thought, Braidotti (2011, p. 2) explains, therefore rejects ‘a negative definition of desire as lack inherited from Hegelian dialectics’ to enable the conditions for ‘lines of flight and zigzagging patterns that undo dominant representations’.

This turn towards affirmative conceptions of desire and power allows me to approach the analysis about digital media, blockchains in this case, and move away from perspectivalism and meaning-making in my analysis that might lead me to postulate what a blockchain is and what it means in the context of capitalism today (Mol 2002). Instead, an affirmative analysis moves inquiry closer to record and explain something about “who does the doing” of blockchains and how power operates to produce multiple realities for people building, using, and talking about blockchains (Mol 2002). Or, to lean on Mol’s (2002, p. 25-6) (much more eloquent) words when discussing the enactment of arteriosclerosis: an emphasis on power relations underscores the reality that ‘events are made to happen by several people and lots of things. Words participate, too. Paperwork. Rooms, buildings ... an endless list of heterogeneous elements that can either be highlighted or left in the background, depending on character or purpose of description’.

To recapitulate, then, becoming and nomadism highlight a process ontology where subjectification emerges impermanently, with subjects inhabiting particular, minor

positions that are prone to ruptures, failures, and arrogation by more dominant (or molar) formations. These concepts reveal the ways bodies are ensconced in power relations and how both produce multilayered and complex subjectivities. Becoming and nomadism prompt questions about subjects specific to their momentary and varied contexts, all the while foregrounding how these contexts and emerging subjectivities can incite creative thought and the production of new concepts or thinking that oppose the status quo. Becoming and nomadism offer useful conceptual framings to sketch out some of the ways subjects form, traverse, resist, and are reterritorialized through encounters with digital technologies, specifically blockchains, and the diversity of ways these media become economic. More specifically, becoming and nomadism acknowledge that subject formations are nonunitary, nonlinear, and anti-essentialist, providing a framework to examine some of the ways blockchain economization can involve an animated but unruly, or *rambunctious*, dynamic of capitalism.

In the following section of this article, I sketch out some of the ways blockchains are objects used for a diversity of economic practices, sometimes entrenching capitalism as we know it (in a dominant sense) while also revealing other forms of economic difference. This rambunctious attribute of capitalism, I argue, detailed through processes of subjectification, reveals some of the embodied and multiple realities of life with and on a blockchain. Specifically, I conduct my inquiry by charting out a critical cartography of blockchain subjectivities that became apparent to me as a user, researcher and worker in the cryptocurrency and blockchain industry since 2013. Analyses presented in this and subsequent articles oscillate between autobiography, autofiction, auto-ethnography, and qualitative research.

Rambunctious capitalism

As vortices of capital give way to helices, axial, or radial formations, they collide with what Dyer-Witford (2015, p. 31) would relegate to the autonomists' proletariat, or the 'hostile and unruly force to be coercively subdued'. With blockchains, capitalism's 'unruly force[s]' are not always 'coercively subdued' or even abated. Rather, these digital media reveal capitalism's unpredictable possibilities that either hasten the 'machinic whirlwind' of capitalism (Dyer-Witford 2015, p. 25) or take it off course, beyond circular processes, gyrating towards majoritarian and minoritarian possibilities. These minoritarian possibilities expose the unruly logics of the digital economy organized by blockchains. Through the digitization and distribution of attributes and data, blockchains redirect established flows of capital in irrotational ways, reconstituting class relations, labor, and work. The obstreperous arcs of capitalism that materialize through and on the blockchain promise a multitude of economic possibilities that can operate simultaneously to ensconce capitalism's dominion anew, or undermine it in some capacity (Gibson-Graham 1996). With blockchains, economizing practices become inherently rambunctious: code, discourses, documentation, protocols, and subjects are prone to succumb to capitalism's grip, but they are not always-already subsumed by its logics. When they are, the recoding of subjects by capitalism is not always coherent, or complete. Indeed, the discourses and deployment of blockchains may, at times, undermine capital's flows of actualization, revealing mutating or nomadic subjects. Through the blockchain, the digitization of data can produce the conditions for capitalism to sustain itself, but it can also open up other, alternative economic relations to come into existence, establishing situations for subjects to emerge and transit from

one point to another (Braidotti 2002; Gibson-Graham 2008). These latter scenarios reveal moments of economic difference, exposing spaces for generative networks, practices, and subjects to coalesce, even if they materialize only momentarily. As Gibson-Graham (1996) noted nearly a quarter of a century ago, 'if capitalism functions as a unity, it cannot be partially or locally replaced' (p. 263). A transition away from capitalocentric discourses and towards economic difference exposes capitalism's instabilities, ruptures, and heterogeneity, and locates alternative and changing economic subjectivities that can inhabit liberatory openings, abandon, or eschew them altogether. I think through capitalism as it materializes through blockchains in the hopes of identifying some of its variances, and where, when, and how it might be 'partially or locally replaced'.

Rambunctious capitalism can therefore be summarized as a set of practices that involve unruly, inchoate, and animated trajectories that can intensify or partially dislocate capitalism. In blockchains, this rambunctious element is intensified. Blockchain capital flows in rowdy ways, accelerating the accumulation of capital and creating newfangled forms of enclosure, exploitation, and dispossession. From the productization of bitcoin's open source code, bitcoin ransomware and phishing scams, to "have fun, stay poor" (Figure 2.1) memes dominating cryptocurrency discourses and aimed at driving up cryptocurrency prices, there exist numerous examples where blockchains are part and parcel of capitalism (Kuhn 2021). Blockchains enhance the volatility of existing capital flows and processes and this becomes evident if one reads about the latest cryptocurrency bullrun, the astronomical rise of NFTs, or by brand desirability of the word blockchain (Shapira and Leinz 2017). In other cases,

blockchains can cause capital arcs in other, unanticipated ways to establish conditions for economic difference to actualize. These blockchain initiatives illustrate the media's capacity to establish diverse flows of generative power, where joyful subjects form



Figure 2.1. Have fun staying poor meme (cf. 'BitcoinBull' 2021).

through amity, intimacy, and mutual aid, even if their inhabitation of those positions and locations are brief.

Rambunctious capitalism involves a bricolage of conceptualizations of capital and capitalism that theorize capitalism beyond the gaze of a single, universalizing perspective. Rather, I propose that this rambunctious characteristic of capitalism can be understood through many possible multidimensional perspectives that can be applied to analyse the ways blockchains enact diverse and exuberant practices of economization (Mazzei 2017). These practices foreground bodies, subjectification, and recognize economic difference. I draw upon feminist political economy interventions from

geography and cognate disciplines as well as select cultural economic texts grappling with questions relating to digital economies and capitalism to construct this framework.

My use of the adjective, rambunctious, to compare capitalist processes on blockchains extends prior efforts to describe the evolving chaos of capitalism, or what Dyer-Witheford (2015, p. 19) following autonomist Marxists and the post-*operaismo* tradition calls cybernetic capital's 'vorticity'. According to Dyer-Witheford (2015, p. 21):

we ... apply to capital its own self-understanding of its processes as those of a vast vortical storm ... a system that sucks up human and natural energies, transforms them into commodities bought and sold in a circulatory process that accelerates in speed and expands in scope until its super-storm engulfs the entire planet.

Dyer-Witheford's (2015) own metaphor of capitalism as a vortex builds upon a history of comparisons describing capitalism as an 'uninterrupted system', 'maelstrom', "whirlpool", and a 'storm' (cf. Dyer-Witheford 2015, p. 19-20; see also Benjamin 1969, p. 257; Berman 1982, p. 15; Land 1982, p. 106; Marx and Engels 1964, p. 63). In many ways, my classification of capitalism as an inchoate set of forces extends conventional representations of the term from political economy. Yet, as Dyer-Witheford (2015) goes on to explain, capitalism's more recent crises, such as the "chaotic volatility" associated with the 1987 and 2008 financial crashes, entrench turbulence as a core feature of its system (see also Mandelbrot and Hudson 2004). In an attempt to account for the instability and systematized incoherence of digital capitalism, and to foreground the animated and enlivened materiality that participates in its reproduction and entrenches its hegemony, I differentiate capital processes involving blockchains as rambunctious. The analysis presented here does not invalidate other forms of economic analyses that

echo the instability of capitalism. It does, however, differ from Dyer-Witherford and other Marxist-inspired conceptualizations of capitalism in that I do not position rambunctiousness as one feature in an otherwise *totalizing* capitalism. Rather, rambunctious, here, implies exuberant movement and animation that is unpredictable and uncontrollable but not necessary and not always reproducing the inevitability and universality of capitalism. Capital's boisterousness is an evident attribute of blockchain technology, where capitalism and its instruments appear and disappear in exuberant and exciting ways, all the while wreaking havoc in unanticipated and obstreperous ways. Capital's trajectories on the blockchain can span everything from cryptocurrencies that are pumped and dumped within a matter of minutes, to circumventing censorship and bypassing state-imposed economic sanctions, or as a tool for activism, community building, or to promote mutual aid and redistribution (e.g., Bailbloc). Blockchains are one of various technologies introducing variability into the chaos that is capitalism, destabilizing the cyclones of capital accumulation, fixes, and crises, all the while activating nomadic subjects that reconfigure conventional interpretations of class, labor, and work.

Rambunctious capitalism and class

Class, Gibson-Graham (1996) explain, involves a series of processes rather than binary categories of the proletariat and bourgeois conventional to Marxist and other heterodox political economy. A process analysis of class counters assumptions that capitalism is a totalizing force, where class formation is preset (Gibson-Graham 1996). Angela McRobbie (2016) also calls for a departure from the Marxist dualism of proletariat/bourgeoisie. The proletariat/bourgeoisie binary, McRobbie (2016) submits, is

inherently problematic because it promises a (false) teleology of an eventually unified working class, homogenizing workers (particularly women) performing historically lower-paying and more precarious forms of work. Gibson-Graham (1996) argue that class formations and relations are complex and prone to change, meaning that people can inhabit multiple class positions at once. Class struggle, therefore, does not 'necessarily take place between groups of people whose identities are constituted by the objective reality and subjective consciousness of a particular location in a social structure' (Gibson-Graham 1996, p. 59). Class, the author argues, occurs anytime there is a change to the arrogation, distribution, or generation of surplus labor (Gibson-Graham 1996). Feminist readings of class as a process align with micropolitical analytics of the concept, surfacing sites and instances where class relations and formations actualize and are embodied in nonunitary ways, and demonstrating the potential to think about economies as diverse (Gibson-Graham 1996).

Blockchains are but one of many technologies that illustrate the heterogeneity and complexity of class formations and relations and how they might lead to the production of nomadic subjectivities. Access to and participation in blockchain systems, as well as one's ability to produce what Marxists call surplus value and surplus labor are always-already fragmented and shifting. The appropriation and production of surplus value and surplus labor, for instance, via mining, trading, or "hodling" (the hoarding of cryptocurrency) can involve contradictory practices, leading participants to inhabit multiple positions at once or carry out similar activities with wildly divergent outcomes.

This becomes evident when considering nomadism and class in relation to the generation of blockchain software and data or tokens downstream of any

implementation. The production of software and subsequent commodification involve variable labor-power and immaterial labor (Berardi 2009). A lot of this labor can be categorized as surplus, meaning that it is unpaid or unrecognized. One obvious example exemplifying the appropriation of surplus-labor in blockchain systems involves cognitive or immaterial forms of labor by way of the forking and subsequent commodification of the original bitcoin code (Moulier-Boutang 2011; see also Hardt and Negri 2000; Dyer-Witheford 2015). The bitcoin core software, or the original codebase, is open-source and under the MIT license, allowing anyone to distribute, commercialize, modify, or use it for private purposes (Bitcoin n.d.). This codebase contains years of contributions by individuals who may never receive any kind of compensation or recognition for the code they commit, or for any profits made by others who choose to commodify merged pull requests. Other contributors, meanwhile, such as “core devs”, in the bitcoin community ascend to celebrity-like status, with a selection of these programmers gaining the figurative keys to the citadel by becoming maintainers of the code base. Anyone can contribute code to bitcoin, for instance, but only a tiny subset of these participants can merge suggested changes to the code, prompting questions about whose intellectual labor gets accepted, acknowledged, and remunerated. This example also demonstrates how emotional labor emerge in blockchain systems, especially across open-source projects. The variability of software production in blockchain systems further reveals the complexity of class as it participates in an inverse relationship between downward mobility and status that McRobbie (2016) describes as involving ‘an inflation of status at the same time as there is a deflation of

earning power' (p. 43). But the core devs example cited above also demonstrates how labor itself flows in dynamic and multiplicitous ways, reconstituting class within sectors.

Blockchain miners offer another example for a process analysis of class.

Someone running a blockchain miner, for example, could inhabit multiple class positions at once and over time. John, a bitcoin and Ethereum miner I encountered during my research, explained some of the ways he inhabited different and even conflicting class positions.

Some context, first: I met John at a cryptocurrency and blockchain event near the beginning of the 2017 "bull run", when bitcoin was trending at around CAD \$2,000 per coin. At the time, he had just bought his second house in an overinflated Canadian real estate market, was debt free, and had invested significant funds in a variety of initial coin offerings, or ICOs. But John's journey as a miner was not that clear cut. He tells me of his entry into mining:

My buddy calls me up one day, early on, and told me about these Antminers, yeah, and he had a deal from a guy selling them at cost. I had just happened to get on track: good job, a girlfriend, and my own place. I had some extra cash and was feeling lucky, so I bought three of these things. At first, I was fucking pissed, you know? I'm not really into computers. I bought these stupid machines to get rich but they were useless, loud, like having a helicopter in your kitchen, they made the place so fucking hot, and they weren't paying off. My new lady – she was threatening to leave, always yelling "shut those fucking things off. I'm getting a migraine" and all these machines were doing was mining worthless coins! So I stop mining for a bit ... Then, one day I hear the price of bitcoin is short of a grand. Bingo, let's go. So I sell all my BTC. It was life-changing. I bought my first truck, ate steak everynight, took my lady out, you know, bought her nice things. I quit my job,

said fuck it, and started buying more miners. Got into mining and trading full-time. And then one day the price crashes ... I'm fucked, sitting with my dick in my hands. I'm broke and no way to pay all these super expensive bills.

John demonstrates some of the ways class operates as a set of heterogenous but intersecting practices. In part due to the volatility of cryptocurrency prices and his early investment in mining equipment, he experienced a 'fractured class identity' through his encounters with blockchain systems (Gibson-Graham 1996, p. 59). His decision to purchase cryptocurrency mining equipment, or antminers, yielded temporary 'life-changing' wealth, altering his class position to one where he and his girlfriend could 'ate steak every night'. It also provided him with some control over his own labor, leading him to quit his job to mine and trade full time. If we only consider the two factors above, John's ability to profit off of the appropriation of surplus value from mining and taking control over his own labor by quitting his job to mine and trade full-time, then we might characterize John's class position as shifting from "working-class" or, in Marxist terms, the "proletariat", to a more conventional "bourgeois" position. But relegating John to binary class positions would elide a key part of his story. The price crash he describes above, for instance, demonstrates that John's class identity varied, leaving him without the means to consistently profit off his own labor and putting him in debt. To be clear, John's story could easily be about financial loss from a conventional fiat financial crash, with very similar boom/bust cycles, but blockchains accelerate and intensify market volatility.

John's story also reveals some of the ways blockchain hardware and protocols can serve as what McRobbie (2016) calls "instruments" or "toolkits" for class transformation, and that these tools do not function consistently. Entrepreneurialism to

initially invest in miners and eventually take up mining and trading full-time can be read as requirements for John's class transformation. His eventual position as an investor and advisor in the blockchain and cryptocurrency industry also illustrates some of the ways these digital technologies create openings for subjects to inhabit different class positions and how these transformations could lead to what Lazzarato (2012) might call a 'reconstitution of society' (cf. McRobbie 2016, p. 35). As blockchain networks create new digital objects subsumed by the logics of capital, early adopters and investors can potentially gain immense wealth. In addition to the seemingly overnight accumulation of crypto-wealth and equally rapid crisis of overaccumulation, early adopters circulate as industry advisers and experts primarily because they are embattled by early failures trying to adopt or profit off the technology.

Hypecycles, which can be defined as the general perception of a given technology's potential value, and cryptocurrency price volatility associated with commodified blockchain objects also fragments the ways by which surplus-value is appropriated and distributed. Surplus-value generated downstream of any blockchain transactions remains hard to pinpoint and subject to the changing conditions of its network(s) (e.g., in the case of a hard fork, tether, side-chain, or price rally), with wide price swings altering class relations. The emergence, for instance, of a wave of bitcoin millionaires following the 2017 and 2021 bull runs recalibrates class in hard to trace ways, lifting anyone who either bought into cryptocurrency early or at the right time to an exclusive echelon of wealth. Early adopters who mined cryptocurrency when it was relatively easy and cheap to do so, or investors who purchased bitcoin when it was "worthless" in many cases get rich overnight due to a sudden move in the market. In

turn, these bitcoin millionaires often become perceived as experts by an otherwise variable and inconsistent ponzified industry merely due to the fact that they got in at the right time.

Conversely, many early adopters and investors liquidated their assets at less profitable all-time-highs, used their cryptocurrency as a poor medium of exchange, or lost access to their funds altogether. For these less wealthy first movers, access to “bourgeois” ways of living are limited or minimized, if they were ever possible in the first place. This very research project offers an example of this. One of my early (and since abandoned) research objectives for this dissertation involved an examination of the fungibility of cryptocurrencies, which meant that, from 2015-2018, I tried to use cryptocurrencies as a medium of exchange (for the purposes of this project). As cryptocurrencies became more expensive to purchase following the 2017 bull run, I abandoned this research objective because it became impractical and expensive. In large part due to the initial framing of my research project, I’ve lost more bitcoin and other cryptocurrencies than I’d like to admit (ask my spouse, if you like), all of which I purchased or mined under the guise of research. Had I held onto those bitcoins, my “class position” would be vastly different than what it is now. Others, like bitcoin expert, Andreas Antonopoulos, are heralded as examples that the community is committed to mutual aid. In 2017, Antonopoulos revealed to the wider crypto-community that, despite longstanding efforts to building the community, create educational resources for newcomers, and promoting bitcoin, he did not have significant wealth from bitcoin. Within hours of being ‘bitshamed’ by a bitcoin evangelist, the wider cryptocurrency community gifted Antonopoulos 100 bitcoins, worth approximately 1.5 million dollars at

the time (Wong 2017). In these instances, class boundaries around the normative upper-classes appear to be porous to moments of redistribution and mutual aid.

Rambunctious capital and labor

Labor is often discussed through wider interventions on work in critical accounts of digital media and capitalism (Gleeson 2015; Jarrett 2016; Richardson 2018). This is in part due to labor's chameleonic forms in digital realms, in which various firms and platforms use software to obfuscate and rearrange labor relations as a means to maximize profit, save on labor costs, and attract a precarious workforce (see, for example, van Doorn 2017). Digitization complicates how we understand labor and work, especially in the context of cultural and creative industries, where the former is often constructed by technology companies as an empowering if not fulfilling experience for "doers", that is also designed to offer escape hatches from managerial modes of daily work. Citing Ettliger (2014, p. 100), for instance, Richardson (2018) explains that the "openness paradigm" of digital work leads to practices that can be emergent, or wavering forms of 'self-exploitation and self-fulfillment' (p. 246). These emergent forms of work rely on the extension and intensification of labor through a variety of intermediaries, co-creation frameworks, and a fragmentation of work locations (Richardson 2018). Gleeson's (2015) analysis of labor performed online for feminist campaigns also demonstrates how digital labor can be underpaid and lead to burnout.

Van Doorn's (2017) analysis of "platform labor", or the software-driven intermediaries that create the infrastructure for many on-demand and temporary labor practices today (e.g., Uber), further illustrates some of the ways digital technologies fragment and render the material realities of labor invisible. Online platforms like Uber,

for instance, use “immunity” strategies, such as obscure and changing terms of services aimed at protecting corporations from providing workers with benefits, information asymmetries designed to nudge workers to improve productivity, and customer service management systems that ‘shield platform owners from having to deal directly with service providers’ (van Doorn 2017, p. 903). Strategies of control, through surveillance, behavioural nudges, and analytics, as well as discourses of superfluidity/fungibility, van Doorn (2017) goes on to detail, also create perceptions that workers are at once disposable and interchangeable, reconfiguring labor relations in the digital economy.

Evolving “digital” labor dynamics are often discussed in geography and adjacent literatures as a continuation of repressive capitalist practices that “alienate” labor and disempower an already oppressed precariat (Cockayne 2016; Sadowski 2020; Dyer-Witheford 2015; Winders and Smith 2018). But these accounts do not suggest that the outcomes of “digitized” work are in any way homogenous or even coherent, and feminists can offer helpful insights into how subjects labor in digitized contexts. Labor online blurs with leisure and satisfaction, and can often involve unpaid and underpaid forms of domestic labor, revealing another configuration of entrepreneurialism that is needed to support capitalism (Jarrett 2016). I sketch out some of the ways subjects labor with and on blockchains to illustrate how capital operates in erumpent and multiplicitous ways that result in the actualization of diverse and even contradictory subject positions.

Blockchains demonstrate how flexibilized work becomes an unruly container for the ways by which people organize and perform labor in the industry. Many blockchain startups draw on the same or slight variants of wider tech cultures. Daily tasks, for

instance, are often meted out using ticket trackers, and task-oriented productivity is often promoted as a marker of creativity and gumption, or an entrepreneurial spirit. The myth or 'fantasy', as Cockayne (2016, p. 461) describes it, embodied in discourses of 'entrepreneurism' constructs labor as unalienated and therefore 'satisfying', and this remains a prominent feature in the blockchain industry.

Much like in Cockayne's (2016) account, entrepreneurial logics in the blockchain industry impact labor in myriad ways. In early 2015, Richard, an entrepreneur I spoke with during my research, repeatedly mentioned his dedication to advising and building different blockchains because, as he told me,

starting from nothing, just sweat equity, doubt, and some Ikea tables ... to a 50 employee firm, with people who have become family, are paid above labor market averages, where you've built a knowledge base, careers, and a revolutionary product that is freeing people from the conventional economy, from fiat ... There is no better feeling than realizing that all your hard work, late nights, fights with your wife ... were worth it. It all meant something. I did that. I invested in myself. I invested in good ideas. I'm worth it and so are you. You don't get that in a regular job. This is satisfying work.

Richard's statement exemplifies some of the ways entrepreneurialism in the blockchain industry mirrors similar discourses from other tech sectors or startup culture. For Richard, labor and satisfaction are entangled together, demonstrating 'how entrepreneurialism is located in the affective and economic sense of satisfaction in one's work, which is also satisfaction in one's self' (Cockayne 2016, p. 462). Richard, however, associates entrepreneurial attributes to more than just satisfaction. He also links satisfaction to freedom, a common trope in cryptocurrency and blockchain rhetoric,

where labor in this particular and, at the time, esoteric and unregulated industry, is perceived to be purpose-driven and ‘freeing people from the conventional economy’.

In a different conversation, Richard discussed the limits to this satisfaction, linking labor practices in blockchain firms the technology’s mainstreaming in the wider economy. Late one evening in 2016, Richard told me that:

this industry has become a joke. People lease an office, get an AI assistant and a few basement-dwelling programmers, who are completely clueless, but need jobs, build anything, and I mean, any kind of nonsense product, call it a blockchain, and they’ll make some return ... it’s full of jokers. They haven’t read the [bitcoin] whitepaper. They don’t get this space, or the people who built it ... now that it’s profitable, they want in ... they’re changing things, claiming to build community when they’re just suits pretending to befriend nerds and making money off of earnest, smart people. These are people looking to make a quick buck and take advantage of millennials who need jobs and will do anything to work in this industry. It’s sad.

Richard’s disavowal of ‘suits pretending to befriend nerds’ illustrates how processes of subjectification in blockchain systems are complex and not always monolithic. In the first conversation reproduced above, Richard espouses rather orthodox ideas about digitized labor practices that venerate individualism, exploitation, intensified productivity and wider entrepreneurialism, all of which have been linked to capitalism as we’ve come to know it (Harvey 1989; Peck and Tickell 2002). And yet Richard later criticizes other blockchain entrepreneurs that ‘take advantage’ of enterprising ‘millennials’, comments that might better align with Leftist or radical thinking. Richard’s contradictory positions on entrepreneurialism exemplify some of the ways affective and flexibilized labor produce multiple subject locations and how capital flows through this sector in

unpredictable ways. These flows read as simultaneously reproducing and intensifying capitalism through exploitative labor practices, while also creating moments of counter-actualization, where power flows in generative ways.

Labor practices in blockchain sectors can also vary depending on the nature of work, enabling some participants to gain upwards mobility. Many miners I spoke to, for instance, began contributing resources to the network as a way to generate passive wealth and in response to consistent or seasonal unemployment. As Justin, a miner from Scotland I spoke to, shared,

I'm disabled ... I've been fired so many times for having a bad day... I can't get out of bed or function properly ... Employers don't value inconsistency or disability. So one day I get fired from this job because I stayed in bed with a migraine, which are actually more serious than most people think. I was down, you know. It was like a punch in the gut telling me I'd never be good enough ... I was on the computer reading reddit, yeah, and went down a rabbit hole about bitcoin. People were posting about mining as an income, you know. I figured why not give this thing a shot and see if I can make some cash. All I need is to buy the gear and then run it in the background. It was like a lightbulb went off. I don't have to be healthy to work, but I can work anyway ... I ended up quitting when my miners weren't really mining anything. Oh yeah, right, and a key reason was one of them caught on fire, and that was scary, but it gave me an independence to work. I needed that.

Justin's story highlights some of the ways blockchains, like other forms of digital work, extend labor 'micro-practices' and work by extension into his home, repurposing personal space into a workplace (cf. Richardson 2018, p. 247; see also Hislop and Axtell 2009, p. 72). Based on his account, Justin found an "independence to work" by mining, but he also bore the risk and responsibility of creating and coordinating a

workable space to labor with his mining machines. He eventually quit mining because, he says, they were no longer profitable and because one of his machines “caught on fire”. Justin’s account surfaces the ways blockchain labor participates in obstreperous capital flows, where the flexibilization of work can be perceived as empowering, but does not offer protections of benefits to the worker. Mining, in the account above, exemplifies what Weeks (2011) characterizes as a “postwork” condition, where labor practices are framed as freeing because they create conditions for work that are time-agnostic, or, as Justin puts it, ‘All I need is to buy the gear and then run it in the background’.

Mining, for Justin, also offers insights into some of the ways blockchains may enable upward mobility and access to employment and promising participants, such as miners, with some control over their labor. This flexibility over one’s labor is nevertheless impacted by more intense flows of capital. For Justin, these wider capital flows involve increasing costs to mine cryptocurrency, demonstrating how capitalism can operate in diverse ways with inconsistent outcomes for individuals.

Rambunctious capitalism at work

Feminist geographers have long critiqued the conceptualization of work in political economy, calling attention to the ‘economic monism’ surrounding early provocations on social reproduction that were ‘defined by the requirements of capital’ (Gibson-Graham 2006, p. 34). Under dominant economic framings, work is often defined according to ‘capital-labor and employee-employer’ affiliations (Clement-Couzner 2020, p. 146). Recent feminist contributions on the topic of work therefore emphasize economic difference and the multiplicity of work as paid or unpaid and in relation to production and

social reproduction processes (Gibson-Graham 2006; Winders and Smith 2018). In geography, feminist literatures on work have probed into the value of unpaid work and social reproduction that lie beyond the traditional boundaries of the formal economy (Folbre 1994, 2000; Waring 1988). Others foreground the body as a site for work to take place in different spatial and temporal contexts (McDowell 1997). Work, according to many feminist geographers, is not delimited to the office, but includes myriad unpaid tasks and “domestic” responsibilities, with a large number of both relegated to forms of social reproduction or “emotional” and “care” work (Clement-Couzner 2020; Winders and Smith 2018; see also Richardson 2018). In the context of creative, “on-demand”, and social media work, feminist scholars take up spatio-temporal questions around work to interrogate the value of work, how it is classed, gendered, and racialized, with a noted emphasis on questions around care as well as immaterial and emotional labor (Arcy 2016, p. 366; Clement-Couzner 2020; Cockayne 2016; Richardson 2018). Care, emotional, and unpaid work are often invoked through a wider discussion of affective labor, or, according to McRobbie’s (2016) account, “passionate work” (see also Hardt 1999). ‘Passionate work’ resembles entrepreneurialism in that it is ‘individualistic and conservative’ but it is also ‘identifiably “girlish” and enthusiastic’, generating an ethic of production that is at once feminized and romantic (McRobbie 2016, p. 107).

The suggestion that digitized work is as deeply gendered, for example, as it was under a Fordist regime, is perhaps not in itself a shocking revelation. Yet, a feminist reading of digital work reveals *how* it is gendered, highlighting how inequalities and systems of oppression common under capitalism reproduce themselves and mutate to work on bodies in a diversity of ways. The gendering of digitized work also highlights

how digital work reconfigures spaces, times, and material realities of ‘work, workplaces, and workers’ (Reid-Musson et al. 2020, p. 1463).

In the context of blockchains, a micropolitical analysis of work and gender reveals some of the multiple ways feminized work can become economic. Questions surrounding what counts as blockchain work offer an obvious entrypoint to map out subject locations that participate, reproduce, and counter dominant flows of repressive power. As in other digitized industries, blockchain work can be porous, with work on open-source projects (see bitcoin example above) being informal and often unpaid. Blockchain work can also be partially or wholly unpaid in more formal contexts or workplaces, reinforcing the employee-employer dynamic in some instances and overturning the relationship entirely in others (Terranova 2000). It also relies heavily on care or affective labor, and passionate work, as I detail in the example below.

I met Quentin at a pub in downtown Toronto in 2015. Quentin offered me a job working as an intern on his identity blockchain in the time it took for our server to bring our table menus. Propositions like Quentin’s were frequent, and they were almost always for “feminized” forms of work: usually some kind of internship, social media manager, assistant, events coordinator, or some vague job involving “marketing”. Quentin describes the type of candidate he is looking for: ‘an upbeat sort of girl ... someone who is young, fashionable and extroverted but nerdy ... a friendly go-getter who can crunch numbers ... who will treat her work the way she would her boyfriend’. I was taken aback by the job description, but I played along out of dumbfounded curiosity, asking Quentin to elaborate on day-to-day responsibilities. He responded by telling me that I would be accountable for opening and closing the office, cleaning it,

onboarding new employees, scheduling meetings, bringing water and coffees, getting lunch, and coming up with a communications plan and launch strategy for his blockchain token. Following this description, Quentin then explained that the work would be paid in tokens for his not-yet-existing cryptocurrency. When I inquired about the legality of his venture (unpaid internships are not legal in Ontario), Quentin immediately corrected himself and offered me minimum wage salary for the position. 'Think of it as an opportunity to learn about the industry', he went on.

The example above in many ways confirms feminist readings of feminized work in other creative industries, where passion to be enterprising is understood as a means of production unto itself (McRobbie 2016). Quentin's description of the position and idealization of a candidate is sexist, but it also exemplifies how passion for work and, in particular, aspiration to 'learn ... the industry' is promoted as a mechanism for women to achieve equality (McRobbie 2016). Indeed, Quentin's comment that he is seeking a candidate that would treat the job like a romantic relationship demonstrates how passionate work functions as a form of 'gender re-traditionalization' that positions romance and enthusiasm as necessary attributes for the delivery of work (McRobbie 2016). McRobbie (2016, p. 110) puts it in blunt terms, noting that 'by in effect marrying her work, having devoted so much romantic energy into finding the right job, rather than the right man, the woman can uplift herself into a relatively undesignated middle-class social category'.

While the encounter with Quentin may not surprise the reader but confirm expected gender stereotypes in creative and technology sectors, it was one of many work propositions I received since 2014. Thankfully, they did not all unfold in the same

way. One counter-example to my meeting with Quentin occurred in relation to formal and paid work I was doing for a cryptocurrency wallet and blockchain consulting startup in Toronto. I had been hired by the CEO as a sort of researcher-cum-writer. During my employment, the CEO consistently checked in with me about my wages and responsibility in an attempt to confirm that the work was remunerated fairly, and that my day to day tasks were appropriate for the position. Despite his reflexivity about both matters, he would at times ask me to perform “care” work or emotional labor, including talking to another employee about her “standoffish attitude” because I am “a girl”. In other instances, still, the CEO would ask me to perform caring forms of labor, such as serving drinks to clients and the men of the office, or clean the kitchen because, as a woman, I “can do a good job cleaning”. Interestingly enough, this type of care work was either directed at me or other women, specifically, illustrating that the gendering of work in blockchain firms oscillates between normative gender roles while also at times operating in unruly ways (Winders and Smith 2019).

Conclusion

Blockchains reveal a rambunctious capitalism because they create the conditions of possibility for a diversity of economic spaces, times, and material realities to actualize, yet these conditions are unpredictable. From the volatility of bitcoin’s price in the past 12 years to Wikipedia’s adoption of the cryptocurrency in 2011 to circumvent sanctions placed on them by Visa and Mastercard, there are now numerous examples that illustrate the complexity of blockchains as economizing technologies.

Concepts like becoming and nomadism reveal some of the ways power operates on bodies differently through a blockchain transaction and creates potential ruptures:

the initiation of a transaction datafies the communication of an event across a network of users, becomes capital as data, as token, or property, or potentially dispossesses if a user initiates a transaction incorrectly. Conversely, this same blockchain transaction might also create opportunities for communities to publish and share data without risk of state or institutional interference or censorship, provides an access point to traditional and more exclusionary forms of finance to otherwise disenfranchised or excluded members of the global 99%, or provides new opportunities for social organization, collective movements, and mutual aid.

I mapped out nomadic blockchain subjectivities in this article and discussed these nonunitary and multilayered subjects through a framing of capitalism I describe as rambunctious. Blockchains exemplify a rambunctious dynamic of capitalism, in which capital takes on multiple and unruly lines of flight and actualizes, fixes, or succumbs to minoritarian subject positionings. Rambunctious capitalism, like its other, more conventional forms, is inherently contradictory (Harvey 2014). Yet, rambunctious capitalism departs from other interpretations of capitalism in that it emphasizes economization as an unruly process that does not necessarily participate in a totalizing capitalism (Gibson-Graham 2006). Economic events can become capitalist or incite economic difference, but they don't always tend towards or become subsumed by capitalism in clear or direct ways. In particular, I focused my analysis of rambunctiousness on micropolitical questions: questions that position bodies in multiplicitous situations of power and where power is not purely or by default an oppressive force. Instead, I sketch out some of the ways generative power flows in blockchain systems and what this means for the production of subjectivity: it creates

spaces of potentiality, recognizing that capital, markets, commons, labor, and valorization are shifting and unfolding processes.

This article also introduced key concepts and philosophy informing my thinking and that often operates in the background of subsequent articles. The ideas I find most purchase from can be loosely described as stemming from the realm of feminist new materialisms – these ideas presume economic processes to be material, just like many Marxists would – but they are distinct from historical materialists in a number of ways. First, a number of feminist materialists forego binaries that position materiality as somehow in opposition to representations (Braidotti 2013; Jackson and Mazzei 2013). These two categories are not, in my reading (and following others), in tension with each other. Rather, my analytical framing understands materiality as a process beginning with the animation of matter. Second, it seeks to describe some of the ways blockchains participate in the practice of capitalism while emphasizing the multiple and conflicting realities associated with economic processes involving blockchains. Third, feminist new materialisms highlight the multiplicity of force relations, where power operates as a situation that can be oppressive, generative, or both.

The ideas in this article are also meant to be partial and illustrative instead of diagnostic, offering a critical cartography of blockchains. In this way, my thinking is more akin to an anti-method that foregrounds the partiality and limits of the research (Nordstrom 2018; Jackson and Mazzei 2013). Inherent to rambunctious capitalism and the analysis I put forth in this dissertation is an underlying recognition that the concepts and analysis above are not meant to be read as a theory. I'm interested in sketching out how blockchains code processes to become economic and operate as mechanisms of

capital accumulation, dispossession, exploitation, or resistance, joy, and intimacy, to bear down on certain bodies (mine, in particular, but others, too) and what types of auto-informed reflections might reveal about certain questions like: who can access blockchains/blockchain capital? What/which bodies can navigate these emerging economies? Who is a welcome participant in some of these spaces? How are these technologies understood by regulators as public services? What does it take to survive life today with a blockchain? What do blockchains mean for capital accumulation, resistance/liberation, and affirmation?

Underlying this article, then, is a close reading of micropolitical or embodied questions, relations, and encounters with blockchains and their ancillaries that centers, following Colebrook (2002a, p. 6) and others, the production of subjectivity through ‘the dynamic flux of experience as it becomes through time’. My analysis of subject formation and economic processes associated with the blockchain is therefore ‘not ... determined by pre-given and ready-made concepts’ (Colebrook 2002a, p.6). Rather, it involves a situated cartographic exercise to trace the ‘emergence, becoming or genesis’ of blockchain protocols in order to identify the dynamism and excess of these “disruptive” media (Colebrook 2002a, p. 3). In so doing, I reveal the conditions for mutating subject locations and how blockchains lead to the production of morphing and unruly subjects and economic realities. To put it differently: I trace out an initial, situated map of some of the economic trajectories blockchains enable, instantiate, and undermine. These trajectories are not always economic in the same ways. They are, however, geographical, and the following articles attend to their geographies. In what follows, I shift the focus of my inquiry to examine the actualization of rambunctious

capitalism in three distinct geographical ways: through space (embodiment), matter (discourses), and time (algorhythms).

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Chapter 3

Sticky waddling: An autobiography of pregnant embodiment in Toronto's crypto-economy

Abstract

In this article, I present autobiographical reflections to trace the power relations that stuck to my pregnant body during my doctoral fieldwork. Autobiography exposes the ways I trundled, in figurative and embodied ways, through the research process while navigating fieldwork, pregnancy and work at a cryptocurrency startup in Toronto, Ontario. Analytically, the use of autobiography reveals how generative notions of power, or potestas and potentia, diverge and intersect to produce sticky, waddling subjects: bodies stuck in the constraining flows of potestas, and/or waddling through undercurrents of potentia. Autobiographies of pregnant embodiment reveal the agentic qualities of emotions, highlighting what they do. Situated reflections demonstrate how power, emotions, and (pregnant) bodies become joyful or not. This article extends wider debates among feminist geographers interested in affirmation, emotions, and creative writing methods by demonstrating the analytical possibilities of autobiography to encourage a sustainable ethics under emerging forms of digital capitalism.

Keywords: autobiography; cryptocurrencies; generative power (potentia/potestas); on-demand economy; pregnant embodiment

Disclosures

My interest in this interview is waning as Mark, the CEO of a prominent cryptocurrency startup, is droning on about the power of the individual. I switch the tenor of our conversation and ask him to comment on the state of knowledge production in the bitcoin and wider cryptocurrency community. His response catches me off guard:

This is what we need help with. I need help with research, we need help with report writing ... What are you doing right now? Are you working? ... We're going to be growing ... We're so understaffed. We have so many moving parts. But to do research and help with writing would be fantastic ... What fills your days? When can you start? Wanna start today? Tomorrow? Monday?

A half-assed attempt at stalling, I blurt out that I'm pregnant. 'So?' he asks. 'The baby can work here, too, if you want'. He smirks at me to cue that he's joking. My thoughts are suddenly inaccessible. I stumble through an unintelligible response that ends with me accepting the offer in a roundabout way. Before I finish listing caveats he should consider before hiring a complete stranger, he congratulates me with a high five and asks for my hourly rate.

Before I can respond, his Executive Assistant, Fiona, opens the door to let us know Mark is overdue for his next meeting. Mark interrupts Fiona to let her know that we'll need paperwork, a non-disclosure agreement (NDA), and onboarding documents. She looks at me, obviously puzzled, and asks why. Mark explains that I'm joining the team. I raise my eyebrows and bob my head in a bizarre semi-circular motion as if to confirm, in a non-committal way, that I'm participating in this conversation. Fiona's face slackens into a smile flanked by two dimples, deep and vertical. She crosses the room and extends her hand to congratulate me. I avert my gaze, embarrassed and excited, conscious that this is all very weird and sudden, and that I'm smiling too wide. I feel blush spread red over my cheeks to my forehead, ears, and down my throat. I stand to shake Fiona's hand. She places one hand on my right arm. I lean in too far and nearly stumble, our greeting turning into an awkward embrace. We both go with it. Handshake becomes hug. Everyone giggles as we make our way out of the boardroom. My strides

are confident, stable. My belly, slightly protruding but still undetectable to the uninformed, presses out, stretching my waistband. My clothes are tighter than they used to be, but the fabric of my pants is comforting next to my skin. I thank Fiona and Mark, wave to a motley crew of employees, and leave the office. My smile wanes as I walk down the stairs. I track the tape from the previous hour back and forth in my head, pausing to scrutinize an ambiguous gesture, strange intonation, or my posture. I slouch too much. I was too forward. Why did I disclose? Why did I say yes to the job? Did I say 'yes'? I'm halfway down the stairs when the smell of rising dough from a nearby pizza place works its way up my nostrils. It should smell good, but it turns my stomach. Reflexively, I engage the muscles in my forehead to distract from those constricting my stomach. I hurry out of the building and towards the streetcar stop. I call my partner to debrief about what just happened, in a desperate attempt to seek advice, comfort, or validation, but he doesn't answer. So I call my best friend, Christine. The phone rings as the streetcar pulls up. I'm anxious to get on. The telephone clicks on and I let out a long breath. I hear Christine's voice on the other end, soft and familiar: 'Oh, hey you. How are ya?' My nausea subsides as I settle into one of the single seats near the back doors. The streetcar gurgles into motion. I relax my body and laugh as we take turns sharing absurdities of our respective days. I stretch my legs, lean back, and let myself sway with the streetcar as it pulls away.

The passage above illustrates some of the force relations that configured my pregnant body as I conducted 74 in-person and online semi-structured interviews for my doctoral research project on the geographies of cryptocurrencies. This particular meeting was with the CEO of a cryptocurrency startup in Toronto and ended with a job

offer I didn't anticipate or ultimately want. The startup and its founder were prominent in the inner circle of the crypto-economy, supporting meetups, events, and conferences. Mark, the CEO, was at the core of Toronto's community and involved in many early ventures in cryptocurrency. Landing an interview with him felt like a big win for my research project. I didn't realise that an ethnography of my employment at the company would become part of the research.

The interview with Mark was fairly standard: I asked open-ended questions and he answered them. His responses were detailed, earnest, generous even. Sometimes, he'd explore a tangent, something I'd encouraged at the outset of the interview. Other times, I would riff off of a digression or redirect the conversation towards a topic relevant to my research interests. The interview was mostly a regurgitation of subreddits and grey literature we both read. He repeated mantras of disruption, entrepreneurialism, and half-baked ideas regarding a forthcoming "digital age of value". He sounded like most Bitcoin evangelists in 2016.

I perked up, however, when he offered me a job unexpectedly. An unsolicited proposition to work at the epicentre of the industry I was studying seemed fortuitous and empowering. Yet, discomfort undergirded the encounter and stuck with me as I left my new workplace. I'd accepted a job without thinking through the implications of taking on more work, or the murky ethics surrounding conducting an ethnography and working under an NDA. To complicate matters, I disclosed my pregnancy to a complete stranger who would then be my new boss. I felt particularly constrained by the pregnancy bit because I hadn't even told most of my close friends yet or gatekeepers who knew Mark. I was also cautious of 'intimate acts of self-disclosure' that could lead to hostile,

precarious or even violent situations (Moss and Donovan 2017, p. 11), leaving ‘little room for a [pregnant] “lived body”’ (McDowell 1994, p. 729). Unease ebbed and flowed during my employment at the startup, as I would try to discern whether a hostile comment was the result of my pregnancy, evidence of some of the ‘old hegemonic dominance’ typical of masculinist workplaces, or both (McDowell 1997, p. 204).

Other times, uplifting encounters helped me overcome feelings of doubt or frustration. My impromptu hug with Fiona, the CEO’s assistant, or hearing my best friend’s voice on the phone, are two examples where generative power, or what Moss et al. (2018; see also Braidotti 2011) call *potentia*, subdue its restrictive counterpart, *potestas*. As Moss et al. (2018, p. 55), explain: ‘*Potentia* is the generative aspect of power that creates, produces, and sustains flow; *potestas* is the generative aspect of power that interrupts, squashes, and restricts flow’. By attending to the flows of *potestas* and *potentia*, or how power operates, geographers can better understand how and where the self emerges.

I often felt stuck and weighed down by ‘configurations of power’ that interrupted or moulded exchanges while working at the startup and even during the research process (Moss et al. 2018, p. 55). At the time, the cryptocurrency sector was steeped in a misogynist, “tech bro” culture, with limited gender diversity or pregnant women for that matter (Bowles 2018). Every evening, I would write about how I, a first generation, Iranian-Canadian, non-technical, pregnant woman, managed to waddle through these “sticky” moments as one way to track what my emotions, through my body, were doing, and reflect on the flows of power shaping my place at this startup.

Geographers use autobiography and other forms of intimate writing to expose the locational politics of knowledge production (Moss 2001; Moss and Donovan 2017). Following Moss (2017, p. 205), I present personal reflections from my field journal in this article in an attempt to 'sketch out some micro-connections among the diverse elements that make up various apparatuses I engage with daily' (see also Moss 2014). I organize my reflections into three sections. I begin with a brief caveat concerning the cryptocurrency sector in which this research took place before situating autobiography amidst nomadic subjectification processes and pregnant embodiment. Next, I present autobiographical writing of pregnant embodiment from my time working in and researching cryptocurrencies and blockchains in Toronto. Where necessary, I alter names, titles, and minor details throughout this text to protect the identities of interlocutors, co-workers, and employers working under NDAs. I conclude by considering how autobiography and intimate writing methods can help feminist geographers cultivate a politics of affirmation, especially under the guise of crypto-economies.

This article is one attempt to understand autobiographical writing's analytical capacity to represent how researchers wield and redirect flows of power within processes of becoming (Moss et al. 2018). Autobiography reveals how researchers can transform restrictive forms and flows of power into acts of affirmation rooted in sustainable ethics (Braidotti 2011; Moss et al. 2018). Braidotti (2005/2006, n.p.) describes a 'sustainable ethics' as 'an enlarged sense of inter-connection between the self and others' without a unitary or 'self-centered individualism'. Sustainability, Braidotti (2005/2006, n.p) explains, involves a 're-grounding of the subject in a materially

embedded sense of responsibility and ethical accountability for the environments s/he inhabits'. A sustainable ethics foregrounds relations or forces that direct the body in acts of resistance, intervention, and transformation, while recognizing that bodies can only take on so much change before they 'crack' (Braidotti 2005/2006).

The crypto-economy: peer-to-peer work, on demand

I began my doctoral fieldwork in 2015, when cryptocurrencies like Bitcoin were touted by most of my research informants as a financial and technological panacea to the state and capitalism as we knew it (Nakamoto 2008). Most of my informants promised that Bitcoin and its "disruptive" scions would herald an empowering and stateless economy. Bitcoin and other cryptocurrencies can be simplified as peer-to-peer forms of unregulated, non-fiat, digital cash or assets secured with cryptography. Bitcoin's underlying technology, a blockchain, involves a distributed, timestamping, single-entry ledger that allows users to transfer data in a verifiable manner over a network run by other users with computers. Discourses surrounding Bitcoin intersect with multiple and often contradictory political views, yet those circulating around the blockchain continue to laud it as "revolutionary" and "disintermediating", promising to remove the need for third-parties arbiters (Swan 2016; Tapscott and Tapscott 2016, 2017).

During my fieldwork and employment for a blockchain and cryptocurrency consulting and software firm in Toronto's crypto-economy, I often encountered neoliberal discourses otherwise prevalent in the "on-demand" economy, where precarity, entrepreneurialism, and flexible labor are sold as virtues encouraging emancipation, individual control, and utopian imaginaries of a technocratic future (Cockayne 2016). Contradictions predominating in other "disruptive" sectors of the tech

industry organised many interactions with respondents as well as the labor practices at the startup where I worked, especially as I became visibly pregnant. At times, I was castigated for becoming and/or being pregnant and I experienced hostility from particular colleagues (Gattrell 2011). I was accused of not “adding value” if I didn’t work beyond my contracted hours, if I expressed the urge to eat, or if the fetus kicked “too much”. In these instances, I was often reminded of my disposability as an employee and that creative talent was cheap, overabundant and readily available (McRobbie 2016). Yet these restrictive situations of power were tempered by other affirming interactions configured by acts of care. Interlocutors, colleagues, and my employers were often kind and accommodated requests: doctor’s appointments, academic conferences, or greater flexibility surrounding work due to burn out and exhaustion (Longhurst 2008). The distinctions between work and leisure, flexibility and control, care and productivity were often blurry, emergent, yet intensified (English-Lueck and Lueck Avery 2017, p. 41; Richardson 2018).

While there isn’t sufficient space in this article to theorize about work and flexible labor in emerging crypto-economies, both share attributes of the “on-demand” economy (Cockayne 2016). The ‘on-demand economy’, Cockayne (2016, 73) writes, ‘defies a clearly agreed-upon definition, but usually refers to digital media firms that connect users through two-sided platform-based marketplaces’. While Bitcoin and its descendants trouble dominant definitions of “firms” and ‘two-sided platform-based marketplaces’, they certainly rely on ‘promises [of] both capitalism and its alternative’ (p. 79). Much of the ‘on-demand economy’, including cryptocurrencies or the “crypto-economy”, hinges on what van Doorn (2017) following Starner (2015) calls a ‘workforce-

as-a-service' model: a highly available, contingent and controlled workforce steeped in solutionist narratives of competition, entrepreneurialism, and productivity. In Toronto's cryptocurrency consulting industry, such attributes operate alongside other barriers to entry that homogenize and articulate inequality as a personal challenge to overcome: technical "expertise" and a shared belief in the economic project of cryptocurrencies (Gill and Kanai 2019). Organized by 'masculine norms' (Parker 2017, p. 104), diverse bodies committed to and with an understanding of the technology can cross class, ethnic, gender, and sexual boundaries to work in the crypto-economy.

Autobiographies of (pregnant) nomadic creatures

'Nomadic thought', Rosi Braidotti (2011, p. 2) writes, 'emphasizes the machinic yet vibrant quality of the lived body'. Lived bodies are fleshy, material, and matter itself is 'self-organized and relational in its very structures' (Braidotti 2011, p. 3). An emphasis on material liveliness that emerges through both an 'embodiment of the brain and the embrainment of the body' foregrounds where and how 'biocultural creatures' take up and traverse public and private spaces without privileging one form of life over any other (Frost 2016; Marks 1998; see also Braidotti 2011, p. 2). Nomadism thus recognizes power as an affirmative and restrictive force, or what Moss et al. (2018), following Braidotti (2011), describe respectively as *potentia* and *potestas*. Force relations are always already unstable and subject to resonances and interferences that amplify or dampen intensities of *potentia* and *potestas*. The frequency and flow of power regulates the formation of particular subjects and participates in the becoming of a self, either by creating or limiting spaces for its materialization. A resonance, in one Deleuzian sense, may involve 'an amplification of amplitudes' or 'two waves in a phase' that become

'more "vibrant" in a convergent or divergent fashion' (Plotnisky 2012, p. 21). Meanwhile, an interference could 'involve resonance but is ultimately a richer play of amplification and the reduction of amplitudes' (Plotnisky 2012, p. 22). An interference, therefore, results from the 'addition or superposition of two or more waves that results in new wave patterns' (Plotnisky 2012, p. 22). A heightened emphasis on the relations between power and bodily activities foregrounds amplitudes of joy and its participation in processes of becoming.

Embodiment is one register to consider the specific ways bodies undergo surface (e.g., physical) and internal transformations (e.g., hormonal, neurological) and how bodies actively participate in "meaning-making and material processes" (Kern 2015, p. 68; Moss and Dyck 2002). Longhurst, Ho, and Johnston (2000) explain that what often goes unsaid during a research encounter can be as important to knowledge building as orthodox qualitative methods. Feminist geographers think through bodily encounters to draw attention to which bodies can operate, how, where, and to what social and political effects. Numerous critical and feminist geographers have considered embodiment through a variety of registers, including but not limited to place and difference (Nast 1998; Parr 2001), and the dis/emplacement of bodies, especially in relation to broader questions of difference, gender, and race in the field (Katz 1994; Kobayashi 1994; Mollet and Faria 2017), physicality and bodily limitations (Bracken and Mawdsley 2004; Jokinen and Caretta 2016), exclusivity (Nairn 1999) and disabled bodies (Kitchin 1998; Anderson 2001; Brown and Boardman 2001; Ellingson 2006).

Feminist geographers have also paid close attention to embodiment through the corporeality, regulatory practices, and responsabilization of pregnant bodies in a variety

of spaces (Longhurst 1994; 2000; 2004; Madge and O'Connor 2005; Gattrell 2011; Nash 2012; Thomas and Lupton 2016). Longhurst (1994; 2000; 2008), for instance, interrogated dominant and hegemonic constructions of pregnancy, noting contradictions and ambiguities surrounding pregnant bodies through fashion, bodily exposure, and in public spaces. The proliferation of pregnancy-related apps, as Thomas and Lupton (2016) demonstrate, reinforces the marketability of idealized representations of pregnant bodies while entrenching neoliberalizing practices. Gattrell's (2011) analysis confirms that pregnant bodies are unwelcome in the workplace, leading some women to minimize their pregnancies for fear of recrimination or hostility. Geographical investigations into pregnant embodiment, while diverse, draw attention to broader questions of positionality, especially differentiating between researching and researched pregnant bodies (Longhurst 1994).

Meanwhile, feminist geographers are turning towards autobiographical and intimate writing to acknowledge and celebrate the messiness of emotions and the roles emotions play in processes of materialization (Laliberté and Schurr, 2016; Moss and Donovan, 2017; Moss et al., 2018). An emerging recognition of "the circulation and stickiness of emotions" (Laliberté and Schurr 2016, p. 74) around researchers and research itself exposes processes of becoming for both (Moss 2001). Autobiography, Moss (2001, p. 19) explains, 'is a process, not only in the sense of recording, in the sense of documenting, orienting and analyzing, but also of becoming, in the sense of lives, subjectivities, identities'. Fieldwork encounters can muddy emotions that circulate, stick, and ultimately remain unspeakable or even impossible (Longhurst et al. 2008; see also Laurier and Philo 2006).

The revelation of partial and uncomfortable field interactions that make up otherwise and often overlooked “small data” of research emphasizes researchers’ bodies and the concerted roles they play in the production of any knowledge (Moss 2005; Longhurst 2009, 2011; Jokinen and Caretta 2016). Indeed, as Longhurst (2011, 876), following Purcell (2009), explains in her article on “Becoming Smaller”:

Research and researchers are not easily separable nor is this necessarily desirable. This does not mean that we can all assume to unproblematically know and represent ourselves ... some reflection on our own complex and shifting embodiment can help materialize the notion that our subjectivities as gendered, sexual, as being a particular ethnicity, as having skin that is a particular color, and being a particular body size and shape cannot be easily separated. I recognize in writing this autobiography that while this method aims at (re)presenting an individual—the self—this is not straightforward.

The autobiographies I present below are complicated and evasive representations like those detailed by Longhurst (2011). I represent pregnant embodiment in the context of the crypto-economy to trace how and where power, through potestas and potentia, churned to produce a sticky, waddling subject. Sometimes, flows of power created amplitudes that resonated, where potestas and potentia converged to increase the potential for transformation to occur. Other times, flows of potestas and potentia collided to interfere, dampen, or diverge, resulting in turbulence (Moss et al. 2018). My pregnant body was often lodged between oppressive and empowering force relations, inhibiting me from taking up affirmative positionings, or dislocated by undercurrents buoying me to become a momentary joyful subject.

Amplitudes: Resonances

Joyful

I meet Claudia outside the Fresh and Wild grocery store on Spadina at King Street. Claudia appears unaffected by the morning heat: she's wearing a white sun dress, designer sun glasses, and sneakers. She spots me across the street and smiles, wide and inviting. I smile back. We hug as I climb onto the curb. I'm sticky with sweat, but Claudia doesn't pull away from me. Instead, she holds on, absorbing my body into hers. Eventually, a school of pedestrians nudges us to the west side of the street. We end up at Jimmy's Coffee on Portland and argue over who gets to pay for the lemonade. Claudia wins, and I resign to getting the next round. I upend a tall glass of water, choking on some ice. What doesn't ooze out of pores pressures my bladder, already squished by placenta, amniotic fluid, viscera, and a wriggling fetus. Claudia is one step ahead of me: 'you gonna pee before we go?' I nod and gulp another glass of water before dragging my body to the bathroom. We eventually leave, and begin what turns into an eight hour walk that takes us west, north, east, and all around Toronto before we head south back to Chinatown. We break every twenty minutes or so to share a croissant, people-watch at Trinity Bellwoods Park, indulge in overpriced ice cream in Little Portugal, and eat dinner before we finally go back to the office. We discuss everything from health to our relationships with our families, immigrant experiences, pregnancy and motherhood, privilege and precarity, goals, and Bitcoin. This last topic might seem odd to eavesdropping bystanders, but Bitcoin organizes our relationship. It contributes to our livelihoods in different ways: Claudia is an early investor and co-founder of the cryptocurrency startup where I work part-time. She cuts my cheques, directs some of my professional activities, and participates in decision-making that impacts my employment. She has the power to control my professional growth and mobility, and my participation in the crypto-economy. Claudia also wields her power in loving ways: she cares for me and my

unborn child by preparing iron-rich meals, reminding me to take breaks, and stretch my legs to prevent swollen ankles and thrombosis. On my days off from work, she texts to see how I'm doing. We dine together regularly, and she teaches me Toronto's longstanding culinary secrets, delicious spots tucked away in basements, alleyways, and side streets otherwise invisible to a recent transplant like me. On this particular day, we finally part ways at around 11pm, back at King Street. Claudia blows kisses and waves as I board the streetcar.

Vulnerable

"What say you we go get some grub, change our clothes and go to a motherfucking rave?" Peter jerks his arms back and forth to gesture dancing. I laugh his question off, confident that he's joking. He's not. He grabs my shoulders and probes the depth of my irises with two wide, honey-brown eyes. His pupils expand as my head casts a shadow over his face: "Are you in?" he asks me. I reflexively twist my wrist to free myself from his grip, and knock back my glass of water. The gesture teems with unnecessary drama, but I'm too preoccupied to care about optics. Heat flows through me as my body releases adrenaline. I chew an ice cube and count to ten, hoping to reboot my sympathetic nervous system and kick-start some sort of internal homeostasis. The last sliver of ice melts down my throat, causing my chest to tighten. I hold my breath until my airways begin to relax and re-open. I work through possible responses I can use to avoid lengthy explanations, or having to tell him I'm pregnant. Peter, meanwhile, continues to stare at me with eagerness. Dave, another co-founder who I also just met, walks up behind me and places his arms over my shoulder in his own attempt to coax me to go dancing. He reiterates Peter's request. I search both men's faces for clues about what to say, hoping for some indication about how to proceed. My stomach drops and I rub it in a counter-clockwise motion, seeking guidance from within. I quicken the pace and rub faster, my body a bottle and my unborn child some kind of unassuming djinn. I feel a kick and a

rush. I debate whether to attribute my momentary delight to hormones or faith that my womb and its contents can somehow provide me with magical advice. I clear my throat and tell them I'm pregnant. I exhale relief but my eyes well up anyway. I can feel my throat cinching again. I turn to look at the table in case I start crying. The counter is coated by a patina of dried beer, condensation, and unidentifiable smear. I fiddle with a wet coaster to distract from tears. I don't want to cry in front of these people. I don't know them. Peter doesn't notice. He takes a big step back, scans my body up and down. His jaw drops as he lets out a "what?! congratulations!" His hands are gripping his curly hair as if he's about to pull it all out. Instead, he stretches out his arms and engulfs me in an embrace. He holds me the way I'll hold my child when I'll pick her up from daycare, years after this encounter: arms wrapped around my body, firm but gentle, rubbing the back of my head. Dave's arms layer on top of Peter's and I find myself in shock as I squeeze back, the epicentre of a drunk bar hug, smelling of freshly laundered hoodies and AXE body spray. A chorus of muffled well wishes follow. The guys drain their beers, toasting me before they do, and they start asking about baby names. I feel relieved of my secret, but I'm still crying. Dave smiles and sits next to me. He squeezes my shoulder and gives me more water. I drink and try to modulate my breathing. My heartbeat slows down and he changes the conversation to Bitcoin's block size, a central topic of the conference we're currently attending. Other conference attendees chime in as I regain my composure. I look over to Dave, who gives a thumbs up followed by a fist bump.

The vignettes above reveal the resonances between different force relations, where *potentia* and *potestas* crash together as 'two waves of a phase' or amplitudes of joyful embodied experiences (Plotnisky 2012, p. 21). In the first passage, Claudia and I share an intimate day out, sharing food, drink, and personal details about our lives. *Potentia* subsumes any *potestas* lurking beneath the surface and resulting from a tacit

recognition that Claudia holds power over me. In the second excerpt, I channel potestas and transform it into potentia by moving past the fear of disclosure, which resulted in an intimate encounter with two relative strangers. In both instances, vulnerability left me feeling empowered in my pregnancy and resulted in intimacy unorganized by profit-seeking motives (Gregg 2013; Moss et al. 2018). Both vignettes illustrate how the same emotion can result in different force relations: with Claudia, potestas emerges through a vulnerability about our professional relationship, whereas my revelation to Peter and Dave amplifies potentia.

Amplitude: Interferences

Itchy

The urge to drag my nails across my upper belly is overwhelming. Blisters on my skin itch and sting from a combination of sweat, stretching skin and hives, or what my doctor diagnosed earlier this morning as “pruritic urticarial papules and plaques of pregnancy”. As she wrote the script for my corticosteroid ointment, Dr. Adele told me that some people affectionately refer to my condition as “pupppps”. “It’s fairly common ... usually a body rash ... generally occurs in the third trimester. Come back in if it doesn’t get better”, she suggested as she pushed herself up onto the tips of her toes and extended her arm to track the tape measure across my abdomen. Back at my workspace, I smile at the image of my doctor struggling to capture the circumference of my womb before my inflamed torso interrupts my thoughts. I rub my belly with the cotton from my dress to mitigate the discomfort. It doesn’t work, so I haul myself up from my desk and waddle to the only bathroom in the office, located at the very back of an elongated room. I think unitchy thoughts on my way to the restroom, but one of the executives on my team breaks my concentration. He’s calling out at me, from behind. Irritation

intensifies as he places his hand on my shoulder. He turns me around so that I'm facing him. I yank my body down and away to get out from under his grip, annoyed at the unwelcomed physical contact. Instinctively, I ball my fists and square my shoulders, as if preparing to box him. My back begins to prickle. I flex my dorsal muscles in the hopes that my shoulder blades will do my job for me, scratching my back, as I ask my colleague to wait until after I use the washroom. He talks over my request with a litany of work-related demands well beyond the purview of my position. Sensing that I'm in a hurry, he sighs and asks: "Were you on your way to use the bathroom? Can't you wait a few minutes? Girl, you're always in there". Before I can muster a response he continues: "Are you OK? Do you have a medical problem?" A smattering of laughter erupts nearby as some of our co-workers react to his question. I almost laugh, too, but stop myself when it dawns on me that he's being serious. I look at him, then down at my body. I gesture to the bulge draped by my royal blue muumuu, and back at him. I respond with a flat, "no". More laughter from a desk nearby. He taps my arm in what I assume is meant to read as playful and says: "Hurry up, you have work to do". I shrug and shake my head in disbelief, turn around, and continue wobbling towards the toilet, sticky with sweat and itchy with pupppps. I make it to the bathroom and shut the door. I run my nails across my chest, belly, thighs, all the way down my calves and back up to the parts of my back I can still reach. I take a break to splash my skin with cold water. The water tempers the throbbing emanating from what is now scored skin. I rub my back against the wall to get at the middle and overhear my colleague complaining in the next room: "I don't understand why she's always in the bathroom. If you need to use it that much, maybe you should go to the doctor". I close my eyes again and pat my skin dry with a few squares of toilet paper, and start again. I watch my skin turn red as my nails peel off layers. In this moment, I am euphoric.

Angry

A Slack notification pops up on my screen: a private message from one of our executives at the start-up, Duane. I click on the highlighted line and read the message: “Hi Maral. Can u edit this document? It’s for [client] ... need it by 5 today”. I look at the corner of my screen to check the time. My computer clock reads 4:38PM. I groan and spin my chair to see if Duane is at his workstation. He is. I message back to ask if this task just came up – why didn’t I hear about this during our morning scrum? Is it urgent? His response makes me chuckle, but not because it’s funny: “been working on it for two weeks ... telling you now because that’s when I’m telling you... it’s not urgent, but I want it done by 5, at the latest. Thx”. I open the Google Doc to see what it is. A one-pager, or press release, would be doable. The file loads on my screen. It’s a comprehensive report for our biggest clients. It’s a mess: The writing is incoherent, there are random fonts and font colours everywhere. Most of the content is inaccurate or needs to be re-organized. There are figures we don’t have permission to use. I curse under my breath as I write back to inform Duane that I won’t be able to meet a 5PM deadline. Instead of replying via Slack, he calls out from across the room: “It’s not that hard. It’s not like your job is that complicated. It’s just writing and editing”. I can feel my heartbeat reverberate through my desk. My coworker, Madison, makes eye contact with me over her computer and shakes her head, mouthing the word “asshole”. She Slacks me a private message that reads: “tell him to write it if writing is so easy :P”. I respond with, “LOL, you’re not wrong” and a poop emoji. We nod at each other. I decide that I’m done putting up with this shit, so I pull myself up and wobble towards the exit. I turn to face Duane as I leave: “If writing is so easy, why don’t you do it yourself?” I storm out, but I still have to manage the staircase before I can exit the office in a slow but justified fit of rage. I eventually make it onto the street only to see David, another colleague, following me. He apologizes for Duane’s behavior. He asks if I’m OK as Duane storms out of the building to continue yelling at me. David creates a physical barrier between us with his body and

instructs Duane to give me space. But Duane doesn't let up: "What's your problem?" he demands. I also ask for space, but he keeps talking, trying to push through David's body. David eventually nudges him away from me and the two men talk a while. Before long, Duane does a sort of pick and roll around David to talk to me. He apologizes: "I'm sorry if I was harsh earlier. I know pregnant women are forgetful and stuff because of all the hormones and weight gain, so it's OK. Don't worry about what just happened. I'm willing to look past it if you are. Are we good?" he asks, as he moves towards me with a conciliatory hug. I'm stuck somewhere between dumbfounded, exhausted, and uncomfortable to manage a response. I stiffen as Duane places his arms around me.

I found myself lodged between oscillating flows of power in the passages above.

"Waves" of potestas and potentia crashed into each other, each swell diverting the flow or dampening the frequency of force relations. Potestas is particularly vibrant, but I continuously attempt to displace it through affirmation. In the first excerpt, potestas engulfs my body through the itching and my rash, breaking when I'm able to get away from the discomfort of the pupppps and my colleague who castigates me for having to use the washroom frequently. In the second account, potestas lurks beneath my initial reaction to the assignment of an unmanageable deadline, but potentia bubbles up when Madison and I commiserate via private chat. I bolster potentia when I decide to stand up to my co-worker, but potestas eventually solidifies when I fail to carry out meaningful action against my aggressive co-worker (Gattrell 2011). In both vignettes, potestas reorders potentia through affect and is confounded by sex and gender. Both men assert power over me to legitimize their inappropriate behavior by reinforcing expectations that I embody a "girlish enthusiasm" for my work (McRobbie 2016). In the first instance, my colleague infantilizes me by calling me "girl", dismisses my request to chat after I use

the washroom, and reminds me of outstanding work obligations. In the second vignette, Duane “ends” our confrontation (one of many) by hugging me, a ‘carefully crafted version of care’ reserved for the women in the office (English-Lueck and Lueck Avery 2017, p. 43).

Sticky waddling

I heave myself up the stairs towards the main entrance. On my way up, I encounter a Bitcoin Transaction Machine (BTM) user trying to get down the stairs. We both pause to figure out how to Tetris around the other. It takes all of my upper body strength to pull my weight to the top, squish my oversized belly, and make space for the customer to pass by. I push the door open and walk in. It feels good to be back. I miss working here, my friends, and the general drama of the cryptocurrency world. To my left, the company’s Chief Technical Officer’s headphones pulsate ambient polyrhythms for no one in particular. The developers look stressed out, as usual. Sasha and George rush over and greet me with familiar hugs. I disengage, turn around and fall into another embrace, this time with Claudia. She envelops me and we hold each other. It feels like we’re slow dancing without moving. She presses her cheek to mine, gazes into my eyes, and rubs my belly before her usual litany of questions: “Are you sleeping? How’s the sciatica? How much longer to go now? 2 months?” She massages my arms as she quizzes me for information. She saunters and I waddle across the office. I slump into one of the couches and attempt to catch my breath without letting on that I’m winded. Employees amble over one by one to check in or update me on the latest developments in the community. Sasha punctuates a conversation with our data scientist about infant sleep with a glass of red wine. Surface tension keeps the liquid from spilling over and Claudia bursts out laughing at the gesture. Sasha flashes me a confused grin. I thank him for the wine, and place it to the side. Amanda comes over, picks up the glass and reminds Sasha that I don’t drink.

Sasha blushes an unnecessary apology as the CEO comes by to greet me. His presence has a dispersing effect: everyone scuttles back to their workstations. Like fish disturbed by intrusive movement, employees retreat to avoid reprimand, wrath, or more work. Unaware that he's loathed by staff, he continues talking. I indulge him by discussing pleasantries, complimenting him on his latest interview in a cryptocurrency news site and nodding as he regales me with updates from industry movers and shakers. As soon as we exhaust non-work related topics, he enquires about my health: "are you OK?" I frown, taken aback at his question. I'm not sure how to respond. Sensing that he's being misunderstood, he explains: "I remember you had some sort of complication with the baby earlier in the summer. Hopefully, everything is OK now?" I laugh, realizing that he's just being nice, following up about my puppps. I nod and thank him for asking. He responds with "of course, I just hope everything is OK".

Potestas and potentia operate on different, but parallel, planes in the vignette above as I am bolstered by a visit to my old workplace. While my encounters are generally positive, they are punctuated by the toxic work culture underlying my place of work. The CEO is ignorant that all of his staff are terrified of him, retreating every time he enters a room. Meanwhile, he shows me kindness by taking the time to catch up and even inquiring about my fetus' and my health. These contradictory force relations exemplify how power, especially through pregnant embodiment, can operate on competing registers. Expressions and acts of care towards my health and my unborn child's wellbeing from my former bosses and co-workers undercut restrictive power circulating through the office. These "interferences", as Deleuze calls them, diminish any "amplitudes" of a resonance, thereby limiting openings for potentia to emerge.

Conclusion

I extracted the vignettes in this article from my field journal, yet I don't remember any of the encounters or events described above save two: my day walking around Toronto with Claudia, my boss, and the altercation with my co-worker, Duane. The force relations evident in the two excerpts are almost diametrically opposed: the former an intensely joyful recollection and the latter heavy with discomfort, anger, and hostility. Both passages exemplify sticky waddling: how one can waddle along to become, however momentary, immanent, and the challenges of becoming unstuck under restrictive power, or potestas, that bear down on the body. Both encounters demonstrate what emotions do and how these intimate, embodied relations, in turn, can 'become the data' (Besio 2017, p. 190).

In this article, I use autobiographical writing from my time as a pregnant employee of a cryptocurrency startup in Toronto during my doctoral fieldwork to consider the force relations that collided with and shaped my pregnant body. These "thrills and threats" of pregnancy, as Thomas and Lupton (2016) call them, were often the result of generative forms of power, which either involved oscillations between restrictive and/or empowering situations, and in which my increasingly pregnant body shaped and was shaped by the research itself: pregnancy opened up opportunities for professional growth or intimacy with interlocutors and colleagues, yet it was also used as an excuse for professional derision, aggression, subjugation, and even harassment.

This article contributes to feminist geography scholarship by reflecting on pregnant embodiment as one way to cultivate 'different imaginaries of embodied social, economic, and environmental practices' (Kern 2015, p. 79). Autobiography emphasizes

the shifting intersections between force relations and pregnant bodies while also situating some of the emergent boundaries of work in “on-demand” economies (Kern 2015; Cockayne 2016; Richardson 2018). It exposes the resonances and interferences of force relations and, in doing so, can encourage feminist geographers to cultivate a sustainable ethics. As Braidotti (2011, p. 93) explains, ‘an ethics of joy and affirmation ... functions through the transformation of negative into positive passions ... ethics is consequently about cultivating the kind of relations that compose and empower positive passions and avoid the negative ones’. Memory-work can detail a body’s attempts to become joyful, while making explicit the “ethical nausea” or limits to transformation associated with ambivalent or negative encounters (Braidotti 2011, p. 165). As the crypto-economy becomes mainstream, such transformations may, for instance, reveal how embodied (pregnant) anxieties and joyful encounters differ from or reproduce masculinist work of the creative or digital economy (McDowell 1997, p. 205; Richardson 2018). Transformations also expose how ‘logics of care’ intensify gendered inequalities, help cultivate relationships, and encourage small acts of resistance in creative economies (English-Lueck and Lueck Avery 2017, p. 41; also, see McRobbie 2016).

The reflections presented above demonstrate one way autobiography can be used as an analytical tool to trace where and how ‘power works in the process of becoming’, and in relation to notions of potestas and potentia, emotions, and pregnant embodiment in the context of social life in the cryptocurrency sector (Moss et al. 2018, p. 54-5). Potentia opens up possibilities for subject formation rooted in affirmation instead of negativity or lack, thereby increasing our collective endurance of potestas, especially as it intensifies under the “workforce-as-a-service” models characteristic of

creative and on-demand economies (Cockayne 2016; McRobbie 2016; van Doorn 2017). Identifying generative moments in autobiographical texts can uncover situations where subjects can emerge, carve out, and sustain spaces of transformation, however momentary.

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Chapter 4

Algorhythms of a blockchain hard fork

Abstract

In this article, I use ethnographic methods to explore the temporal effects of algorithmic processes, or *algorhythms*, leading up to and resulting from the 2016 Ethereum blockchain hard fork. The hard fork erased blockchain transactions to return funds to users following a costly hack. Specifically, the hard fork instantiated a new version of the network, duplicating existing cryptocurrency tokens, inflating the price of cryptocurrencies, and opening up new markets. The Ethereum hack and hard fork reveal the ways that the orchestration and execution of code can create algorhythms, highlighting how code participates in the creation of diverse temporal conditions for capital to accumulate, circulate, and produce uneven geographies. This article argues that blockchain hard forks function as mechanism of value generation to enact multiple spatio-temporalities and contributes to wider discussions about the temporalities of algorithms, computation, and digital geographies.

Keywords: algorhythms; auto-methods; auto-ethnography; blockchain; cryptocurrencies; Ethereum

Introduction

In this article, I consider the temporal effects of the 2016 Ethereum blockchain hard fork, or what Miyazaki (2012) calls *algorhythms*, to better understand the temporal realities, or rhythms, that algorithmic processes enact. As Miyazaki (2012) explains, close examinations of the 'rhythmicity of computation and communication' are crucial to understand the specific workings of digital technologies or how algorithms make

oscillations between software and matter audible (see also, Mattern 2020). For Mattern (2020), algorithemics involves a 'holistic practice, extending across spatial and temporal scales' that encourages the recognition of 'submerged sounds and obscure patterns, with and without machine'. On a blockchain, an algorithmic analysis exposes how specific events, or, in this case, a hard fork – an event that replicates a blockchain according to a different, forward-incompatible version of the source protocol – draws attention to code's capacity to organize, interrupt, and generate multiple and contradictory temporal cycles, or what Edensor (2010, p. 1) calls a 'patterning of a range of multiscale temporalities'. An examination of the algorithemics of distributed systems also builds upon Kitchin's (2019, p. 787) recent call for digital geographers to investigate the 'politics of time' (Kinsley 2014; Ash, Kitchin, and Leszczynski 2018; Richardson 2018).

The present study uses ethnographic methods to contribute to recent scholarship examining the relationships between time, computers, and everyday life in an era of ubiquitous computing. In this article, I examine the diversity of micro-temporalities actuated by algorithms through one specific algorithmic event: a blockchain hard fork. Algorithms emerging from blockchain hard forks demonstrate some of the ways that computation can create the conditions for time to materialize in fragmented, plural, and disorderly ways, or find pace and synchronicity (Miyazaki 2012). On a blockchain, algorithms that result from hard fork events give rise to new spaces for capital to accumulate through the duplication of existing cryptocurrencies, and the creation of new cryptocurrencies and unregulated markets.

In this article, I apply Miyazaki's (2012) concept of algorithmytics and recent geographical contributions to digital time (Ash 2019; Coletta and Kitchin 2017; Kitchin 2019) to argue that the orchestration and execution of code through blockchain hard forks can enact multiple temporal realities, and that the resulting algorithmic temporalities, or algorithmytics, diverse in their own rights, highlight the ways code participates in the creation of diverse conditions for capital to accumulate, circulate, and produce uneven geographies. Analysis of the 2016 Ethereum Decentralized Autonomous Organization (DAO) hack and its subsequent hard fork reveals software's capacity to assimilate existing temporalities, create multiple as well as irregular temporal realities, or polyrhythms and arrhythmias. Subsequent blockchain hard forks on the bitcoin network impacted the organization of digital time differently, generating inconsistent temporal conditions for capital to emerge, circulate, and benefit some while harming others.

In what follows, I employ ethnographic methods to contribute to the scholarship on cryptocurrencies, blockchains, and digital geographies more broadly. Specifically, I consider the effects of specific, time-bound and time-dependent blockchain computation. I begin with an overview of the vast and pluri-disciplinary body of literature on cryptocurrencies and blockchain technology. Next, I engage with post-positivist interventions on time, including Miyazaki's (2012, 2013) concept of an algorithmytic to consider the relationship between software and time. Following a brief outline of my research design, I present excerpts from my doctoral field journal to interrogate the temporal effects of the 2016 Ethereum hard fork that followed the DAO hack. I then set my analysis of the Ethereum hard fork against a prefatory discussion of subsequent

hard forks of Bitcoin's blockchain. I conclude by outlining future considerations for geographers interested in the algorithms of digital new media, such as cryptocurrencies and blockchains.

Time on the blockchain

Cryptocurrencies and blockchain technology remain confounding topics to discuss due to the complexity of the technology, hype, and obscurantist narratives peddled by cryptocurrency evangelists. By solving what is commonly referred to as the double-spending problem, where a user can spend the same digital currency twice, Satoshi Nakamoto (2008), Bitcoin's unknown creator, outlined a framework for peer-to-peer, stateless, digital cash. With bitcoin, users can exchange privately-issued digital tokens asynchronously and directly with other parties by publishing every transaction on the network to a distributed ledger. This append-only record lists blocks of data comprised of batched and timestamped transactions that are verified and secured by other network peers. As these batches of transactions are vetted by the network, they are listed in a chronological sequence. Each block of transactions includes a hash of the preceding block, encoding the periodized history of network events into blocks (Cachin and Vucolić 2017). This periodized sequence of batched transactions comprises what most people call a blockchain.

Unlike traditional banking, which still requires double-entry bookkeeping to ensure the veracity of a transaction or claim on money (e.g., a cheque) and thus uses software to *represent* money, bitcoin peers use special hardware to *mine* or labor for tokens. To mine a bitcoin, humans direct computational power to solve complex puzzles and verify transactions submitted to the network in exchange for new tokens. Mining for

tokens provides an economic incentive to run and secure the network. Once mined, or generated, tokens can be held as speculative stores of value, or used as a variably regulated global currency. To ensure that the appropriate users are observing blockchain transactions according to the consensus or rules set by the protocol, mining tends to be resource intensive. In bitcoin and other cryptocurrencies like Ethereum, the resource applied for mining is compute power. Recently, cryptocurrencies like Ethereum are currently exploring alternative, less resource-intensive methods to secure network transactions.

Much of the excitement over the blockchain comes from its potential to leverage algorithmic processes to verify network events. Blockchain protocols (like the one used by the bitcoin network) ostensibly remove the need for third parties to mediate digital peer-to-peer transactions and log transactions such that they cannot be altered or reversed without some violation to the network's rules (Tasca and Tessone 2019). Both features presuppose what Swan and De Fillippi (2017) call 'algorithmic trust', whereby 'intelligence is built directly into the network's operations through a sophisticated protocol that automatically identifies, validates, confirms, and routes transactions within the network' (p. 605).

Underlying the blockchain's "algorithmic trust" are two concepts: immutability and consensus. A blockchain's immutability provides users with a level of assurance that the data can be trusted and network events have not been corrupted (Tasca and Tessone 2019). Tasca and Tessone (2019, p. 6) caution, however, that, while 'blockchains are technically immutable, from a governance perspective, this immutability is never fully realized'. This is, in part, because immutability is contingent on the protocol's design

and, specifically, the algorithmic model used to ensure consensus across individual nodes or peers operating asynchronously to verify network events (Cachin and Vulcolić 2017; Pahlajani, Kshirsagar, and Pachghare 2019). Consensus algorithms therefore set the rules for a blockchain network to achieve immutability and outline the specific conditions under which network peers can trust that a blockchain's representation of historical events is accurate. Blockchains that use a proof-of-work algorithm (e.g., Bitcoin and Ethereum, at the time of writing), for instance, can be reversed or altered if a majority of network participants endorse an alternative version of network events, or reverse a decision (Tasca and Tessone 2019).

Timing plays a crucial role in achieving consensus on a blockchain because it determines the order of operations that guarantees that the blockchain reflects a “true” history of network events. Drawing upon Schneider (1990), Cachin and Vucolić (2017, p. 4) assert the significance of time in relation to achieving consensus, stating that the:

task of reaching and maintaining consensus among distributed nodes can be described with two elements: (1) a (deterministic) state machine that implements the logic of the service to be replicated; and (2) a consensus protocol to disseminate requests among the nodes, such that each node executes the same sequence of requests on its instance of the service.

The blockchain therefore relies on consensus among its users to ensure consistency across the network in order to ‘generate computational proof of the chronological order of transactions’ (Nakamoto 2008, p.1).

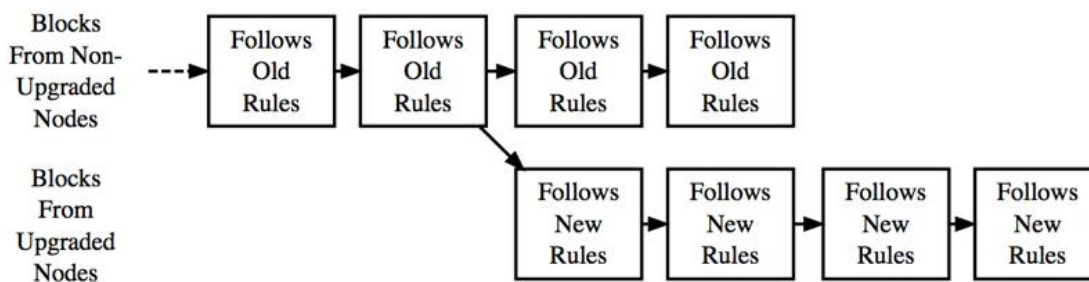
Time also matters to blockchain consensus because each node on a network must find a way to synchronize operations with other nodes while accounting for any temporal variations that arise across different peers. Indeed, the problem of

synchronicity has been a longstanding topic of study among many computer scientists interested in distributed systems, including blockchains (Lenzen et al. 2010; see also Lundelius, Welch and Lynch, 1984; Shamir and Rajsbaum 1994; Srikanth and Toueg, 1987; Ostrovsky and Shamir, 1999). In blockchain networks, nodes must account for delays in information transfers occurring across distributed users operating under diverse conditions and on different machines. Yet synchronization is complicated by the fact that, even under ideal conditions, nodes are unable to account for unknown temporal variables, or as Lenzen et al. (2010) put it: ‘a node cannot determine exactly how much another clock progressed since the last message arrived’ (p. 62). In addition, each node on a blockchain network may be running a slightly different version of local ‘clock time’ on their machines, and variations between different clock times can result in divergent expressions of time across nodes, or ‘clock drifts’ (Lenzen et al. 2010, p. 2).

Timestamping offers one way to account for variations in time across nodes, a feature Nakamoto (2008) highlights in the Bitcoin whitepaper by stating that ‘the timestamp proves that the data must have existed at the time’ (p. 2). Synchronicity and timing on a blockchain can be impacted by various events or computational processes, such as latency or hard fork events (to name but two). For the purposes of this study, I will only focus on hard forks.

In computing, a hard fork uses an existing version of software to create an incompatible copy of the original source code. On a blockchain, a hard fork can generate an entirely different version of the blockchain’s original code but also historical data published to the legacy version of the network (Figure 4.1). Unlike a hard fork occurring on a code repository, where the source code is replicated for use or altered, a

blockchain hard fork also duplicates existing data and transactions but compiles both according to a different ruleset. Hard forked blockchains therefore repeat the original blockchain's history, including transactions and tokens issued, *until* the hard fork event, at which point the new, hard-forked blockchain becomes an alternative chronology of network events. A blockchain hard fork, as a result, does not merely generate a facsimile of the source blockchain. Instead, a blockchain hard fork results in a mutation of the original network and data, simultaneously preserving network history while initiating a forwards-incompatible version of the source ledger. In addition to creating a different version of the original blockchain, a hard fork duplicates any existing cryptocurrency tokens from the source blockchain onto the hard-forked blockchain. A blockchain hard fork relies on algorithmic processes to reconfigure and replicate some portion of the network's history, bringing about different temporal realities and futures of capital accumulation and circulation.



A Hard Fork: Non-Upgraded Nodes Reject The New Rules, Diverging The Chain

Figure 4.1. Blockchain hard fork (adapted from Bitcoin Project 2018).

In geography, scholarship on cryptocurrencies and blockchains is fledgling, but emerging quickly. Early contributions explore the relationships between Bitcoin or blockchains and economic growth (Connell 2014), rhetorical power and algorithmic governance (Zook and Blankenship 2018), digital economic spaces (Zook 2018),

“algorithmic nations” (Calzada 2018), and forest carbon offsets (Howson et al. 2019). As geographical scholarship continues to surface, there is ample room to emplace investigations of blockchains, cryptocurrencies, and other “decentralized” technologies amidst wider debates occurring across digital geographies (Ash, Kitchin, and Leszczynski 2018).

One subset of the diverse digital geographies literature pertains to discussions about time (e.g., Borch et al. 2015), with more recent contributions drawing linkages between temporality, memory, and software (Ash 2019; Coletta and Kitchin 2017; Elwood and Mitchell 2015; Kitchin 2019). Indeed, as Coletta and Kitchin (2017, p. 2) point out, ‘time geography has little considered the role of code and new forms of urban Big Data in reshaping the temporality of urban processes, systems and life’ (c.f. Crang et al., 2007; Schwanen, 2007). In the next section, I engage with these and other related notions of time in the context of digital technologies.

Time, rhythms, and algorhythmics

A number of scholars use time as an analytical frame to expose how it can be a plural, processual, or relational “ontological element” that is inextricably linked to the production of space (Barad 2007; Grosz 2005; Guattari 2011; Lefebvre 2004). Barad (2007) asserts, for instance, that time is not merely an absolute and *a priori* phenomenon that records events in predefined space. Instead, a variety of dynamic forces work together to materialize manifold temporalities and spatialities, or what Barad (2007) calls ‘spacetime-matter’ (2007, p. 181). These spacetime-matterings, Barad (2007) notes, are not necessarily constant but prone to discontinuity.

Grosz (2005) also argues that time unfolds as a variable process linked to the production of space and matter. Time, Grosz (2005) maintains, 'inhabits ... life itself through a variety of activities or 'rhythms, direction, and forces' (p. 5). While some of these temporalities are continuous and shared, meaning that life 'fits with its time', others are what Grosz (2005), following Nietzsche, refers to as the 'untimely' (p. 10, 11). The untimely, Grosz (2005) elaborates, points to that which resists 'the drive of the present to similarity, resemblance, or recognition' or temporalities that don't conform to the norm, are different, and can therefore augur change (p. 11). In other words, Grosz's (2005) conception of time emphasizes its multiple potentialities and its capacity to operate in both anticipated and unexpected ways. Grosz's (2005) notion of the untimely runs parallel to Barad's (2007) conception of discontinuity as both concepts acknowledge the role difference plays in the production of time.

Similar to Barad (2007) and Grosz (2005), Guattari (2011) conceives of time as a process contingent on diverse spatial and temporal interactions. For Guattari (2011), time does not involve an 'interaction between time "in general" and man "in general"' (p. 11). Rather, time is "'beaten' by concrete assemblages of semiotization be they collective or individuated' (p. 107). It is, further, produced by '*this* time and *this* space lived by a particular assemblage, in a *particular* context' (Guattari 2011, p. 105, emphasis in original). What Guattari (2011) means, here, is that time is produced through momentary and repeated interactions, or *rhythms*, between living creatures and things, and that the result of these interactions are specific temporalities, or *refrains*. Such refrains involve repeated temporal and spatial interactions that incorporate minor

differences or variations, and the outcomes of these refrains can alter the temporalities that materialize (Parr 2010).

Lefebvre (2004) also considers time through the notion of rhythm, which he defines as the specific results of an interaction between time and place. Rhythms can be broken down into four concepts: polyrhythmia (a multiplicity of rhythms), isorhythmia (identical rhythms), eurhythmia (harmonious rhythms), and arrhythmia (discordant rhythms) (Lefebvre 2004). Polyrhythmia, isorhythmia, and eurhythmia often involve some sort of harmony or convergence, whereas arrhythmia involves 'a divergence in time, in space, in the use of energies' (Lefebvre 2004, p. 68). In this way, arrhythmia resembles discontinuity or untimely events. Any rhythm unfolding through a process involves social and force relations (Lefebvre 2004).

Rhythms, according to Lefebvre (2004), also rely on three components: repetition, interferences, and processes. Repetition, he argues, introduces difference since 'there is always something new and unforeseen that introduces itself into the repetitive' (Lefebvre 2004, p. 6). Interferences involve struggles between different rhythms, or disruption, a notion that runs parallel to Barad's (2007) discontinuity and Grosz's (2005) untimely. Processes, Lefebvre (2004) argues, can be linear and cyclical, and these two tend to operate reciprocally. Linear processes are comprised of 'routine' events, or what Lefebvre (2004) calls perpetual and chance encounters relating to the 'daily grind' (p. 30). Meanwhile, cyclical processes 'last for a period and restart' (Lefebvre 2004, p. 8).

Miyazaki (2012, 2013, 2018) takes up the notion of rhythm to consider the temporalities of algorithms, or what the author calls *algorhythmics*. *Algorhythm*, a

portmanteau of algorithm and rhythm, can be summarized as temporally-based machinic procedures executed by code and highlights 'the timing effects of computation' (Miyazaki 2018, p. 244). Specifically, algorithmytics focus on the ways computational tasks make ubiquitous but imperceptible micro-temporal events logical and controllable (Miyazaki 2013). Algorithmytics also reveal patterns of interference that become possible through the interactions of code and rhythms, but that are perhaps unanticipated (Miyazaki 2018). An algorithmytic analysis is not always strictly temporal but makes the technical workings and mediation of matter by code audible where they might otherwise become imperceptible or inaudible (Mattern 2020). Algorithmytics therefore prompt us to reimagine how we might become 'listening subjects' (Mattern 2020), highlighting a multitude of shifting temporalities that have the capacity to open up and produce unforeseen spatial and material realities.

In geography, many engagements with time invoke Lefebvre's (2004) work on rhythm analysis and other dominant texts in the field (Hagestrand 1970; Crang 2001, 2007; Edensor 2010; Edensor and Holloway 2008). In part driven by the ubiquity of computing and digital mediation, geographers are exhibiting renewed interest into the productive relationships between time, space, and code, or what Kitchin (2019, p. 776) terms as 'code/spacetime'. As Elwood and Mitchell (2015) remind us, digital media may alter time and space, but they also reconstitute memory and produce knowledge in myriad ways, prompting us to reflect on what gets forgotten and remembered. Indeed, recent examinations of the intersections of code and time highlight a variety of phenomena, such as "fast" forms of urbanism, questions surrounding agency, memory,

and artificial comprehension (Ash 2019; Datta and Shaban 2016; Elwood and Mitchell 2015; Rose 2017).

Meanwhile, a number of geographers and critical scholars have applied Miyazaki's (2013) concept of *algorhythmics* to urban questions (Coletta and Kitchin 2017; Kitchin 2019; Mattern 2020). Coletta and Kitchin (2017), for instance, make a compelling case to consider the ways digital technologies manage and indeed regulate space-times, while Kitchin (2019, p. 776) more recently uses *algorhythmics* to sketch out the ways digitally mediated time and space unfold. Meanwhile, Mattern (2020) uses *algorhythmics* to remind us of 'machines that listen to the city'.

On a blockchain, an *algorhythmic* analysis can underline how code, or hard forks in the case of this study, can "incorporate difference as they repeat giving rise to mutation" where one blockchain chronology becomes two distinct instantiations of itself (Parr 2010, p. 225). Using auto-ethnography, I apply Miyazaki's concept of the *algorhythm* to identify some of the rhythms arising out of the 2016 Ethereum blockchain hard fork and draw attention to their effects on network users. Auto-ethnography serves as a useful method for me to translate blockchain hard fork events and the resulting temporal pulses so that geographers can make sense of spatial processes. The *algorhythms* produced by the 2016 Ethereum hard fork can be multiplicitous (polyrhythmic), sometimes inconsistent (arrhythmic), and other times resistant to more dominant temporal flows, yet they always find some eurhythmia, or harmony amidst wider temporalities. The *algorhythms* of a blockchain hard fork also reveal software's capacity to alter digital memories of collective events, as well as some of the ways blockchains are changing engagement with space and time online. In the remainder of

this article, I summarize my methods and discuss some of the algorithms produced by the 2016 Ethereum blockchain hard fork, followed by a brief analysis of subsequent blockchain hard forks before offering concluding thoughts on blockchain algorithms.

Methods

This article uses ethnographic methods and intimate forms of writing to emphasize ‘how people make sense and meaning of data and technologies in the spaces and practices of their everyday lives, how they grapple with the effects and consequences of living in a digital society, and how these effects manifest differently across space and subjectivities’ (Elwood and Leszczynski 2018, p. 640; see also Moss and Donovan 2018). A targeted focus on code’s temporal *becomings* exposes some of the ‘effects of becoming as a process’ where it is not merely ‘a generic meaning of always in process; rather ... it is productive without being prescriptive’ (Moss and Donovan 2018, p. 229). A process-based approach that foregrounds how and when time might materialize under defined computational conditions and distinct rule changes addresses recent calls that critical digital geographers should be ‘reading for the fluidity and situated knowledge of datasets’ (Giesecking 2018, p. 150).

I use Intimate writing as a mode of analysis to emphasize the ambiguity, banality, and messiness of the research process, while also exposing the everyday realities of life and work under “digital” conditions (Butz and Besio 2009; Brigg and Bleiker 2010; Hawkins et al. 2020; Kinsley 2014; see also Richardson 2018). Inspired by recent contributions on “auto-methods” by Moss and Besio (2019) and Hawkins et al. (2020), I use “memory-work” from my field journal to analyze my own experiences working in and researching cryptocurrencies and blockchains, and how written

“memories” of everyday moments and encounters expose the ways power operates through the body, relationships, and institutions or structures (Hawkins et al. 2020).

In the extracts below, I present reflections of my encounters with members of various cryptocurrency communities during my doctoral fieldwork and as an employee of a cryptocurrency startup. These reflections are auto-ethnographic, as I carried out a variety of formal research activities involving cryptocurrencies and blockchains as part of my doctoral research project (e.g., participant observation at international Bitcoin, blockchain, and cryptocurrency conferences, digital ethnographic methods such as lurking and social media engagements, 74 semi-structured interviews, and informal interviews at meetups). Yet the research process relied heavily on personal and professional relationships developed through my employment and participation in Toronto’s cryptocurrency and blockchain industry. I therefore use intimate writing from my field journal as I researched and worked for a cryptocurrency and blockchain startup in Toronto to examine some of the emergent ways that bodies research and work in “disruptive” digital economies (Richardson 2018).

Toronto and wider cryptocurrency and blockchain communities are prone to discord and fragmentation, exposing anyone willing to speak on matters relating to the community or specific projects to potential risk. I therefore assign aliases to participants and often attribute statements to characters composed of multiple people or interactions in order to protect participants (Hopkins 1993). Given the intimate nature of many local cryptocurrency meetups and, when aforementioned masking techniques are insufficient, I fictionalize dates, settings, and geographical locations of entries (Rabbiosi and Vanolo 2017).

A hack, hard fork, and two blockchains

In 2016, I worked at a cryptocurrency start-up in Toronto, Ontario. The startup was involved in promoting numerous cryptocurrency and blockchain ventures as well as producing its own blockchain products. In April of the same year, another startup, *Slock.it*, launched the DAO, a decentralized autonomous organization. A DAO can be described as an online investment vehicle crowdfunded by investors. Investors purchase digital tokens and apply some or all of their tokens to vote on different funding proposals.

Slock.it, an outfit developing applications to run on Ethereum's blockchain (the second most prominent cryptocurrency after bitcoin), launched The DAO on 30 April 2016 (Prisco 2015). At the time, there was considerable hype surrounding blockchains and the potential for DAOs to popularize crowdsourced and distributed fundraising models. The DAO accumulated over \$150 million USD of investment during its 'creation phase' – a crowdfunding period of 27 days that took place from 30 April to 28 May 2016 (DuPont 2018). The firm I worked at jumped on the DAO bandwagon by spearheading the development of software to support DAO investors. On 17 June 2010, however, excitement over the DAO turned to panic following an exploit or "hack" of the DAO's code. The hack resulted in over \$60 million dollars USD of lost crowdsourced investment (Buterin 2016a; see also DuPont 2018). Various members of Ethereum's community, including its creator, led a variety of efforts to recuperate missing DAO funds and reimburse investors. On 20 July 2016, one such intervention resulted in a controversial decision to carry out an 'irregular state change' of the network, or what is commonly called a blockchain hard fork, to erase the hack from the blockchain and return the stolen DAO funds to investors (Buterin 2016b). While both the

characterization of the DAO as a hack and the decision to rollback time on the blockchain using a hard fork remain hotly contested within the Ethereum and wider cryptocurrency community, these issues are beyond the scope of this article (though, for an ethnography of the DAO itself, see Dupont 2018).

Within less than a day following the hard fork, reports placed over 85 percent of Ethereum's hashpower (computational resources that run a cryptocurrency network) on the new blockchain created by the hard fork (van Wirdum 2016). This percentage of hashpower indicated that, overall, miners were endorsing the hard fork and contributing resources to the new version of the Ethereum network. Yet a minority of dissenting voices opposed the hard-forked chain, claiming that it was a bailout undermining Ethereum's decentralized governance framework, and chose instead to keep using the legacy Ethereum blockchain. Indeed, objectors to the hard fork continued running Ethereum's original blockchain protocol, now renamed Ethereum Classic. Despite hosting a fraction of Ethereum's activity and computational power, Ethereum Classic persisted, surprising much of the Ethereum community, and resulting in a second, distinct version of Ethereum's blockchain. This network split exemplifies what Edensor (2010) calls 'resistant rhythms' or 'different paces and pulses which critique normative, disciplinary rhythms and offer unconventional, sometimes utopian visions of different temporalities' (p. 16).

Ethereum's hard fork erased the DAO exploit and its financial effects for investors by rolling back the blockchain to a prior state. The effect of this temporal erasure returned funds to investors and ostensibly saved the Ethereum network from total collapse. The rollback also led to a chronologic disjuncture: the original blockchain,

renamed Ethereum Classic, historicized the DAO exploit, while the hard-forked blockchain, Ethereum, expunged any evidence of the event. The hard fork also resulted in overlapping timelines, duplicating existing Ethereum coins onto the Ethereum Classic blockchain. Anyone holding Ethereum tokens prior to the hard fork now held the same amount of cryptocurrency on the Ethereum Classic blockchain, with Ethereum Classic tokens priced significantly lower than Ethereum tokens.

The network split also illustrates code's capacity to alter digital ways of knowing, remembering, and communicating with one another across time and space (Elwood and Mitchell 2015). By canonizing dissent of the hard fork decision through the contribution of resources to the Ethereum Classic blockchain, end users and miners have participated in a collective act of remembering. Ethereum Classic exemplifies the vagaries of digital memories and how, in the case of a blockchain hard fork, history is actively remembered through network maintenance. Without concerted efforts to allocated resources to the network, the Ethereum Classic blockchain risks being 'forgotten' (Elwood and Mitchell 2015).

Hard forks in cryptocurrency networks are not uncommon, but my interest in this article is to explore some of the micro-temporalities of a blockchain hard fork and interrogate their political realities. In Ethereum's case, the hard fork erased a portion of time alongside published transactions (e.g., the \$60 million USD DAO hack that occurred on June 17, 2016) from the blockchain while inscribing new rhythms for capital to accumulate, circulate, and benefit some at the expense of others on the hard-forked blockchain (Del Castillo 2016). The hard fork also revealed that memory on a blockchain, as in other smart systems, isn't merely retentive but a dynamic process

(Ash 2019). In the rest of this article, I examine some of the rhythms produced by the Ethereum hard fork.

Assimilating blockchain algorhythms

21 June 2016

“Did you see the thing about the Ethereum guys essentially telling everyone to stop trading?” I roll my chair over to Saul’s desk and look at his screen. He clicks to open a link on r/Ethereum. A chat log loads displaying a lot of text. Saul highlights a line with his mouse, which reads: “[3:43:01 AM] Vitalik Buterin: ok can you guys stop trading”. I scan the rest of the log. The chat is a lengthy back and forth between some of the Ethereum team and cryptocurrency exchanges about a decision to halt all ETH trading due to The DAO hack. “Dino”, a participant in the thread, surmises that, ‘without a hard fork and rollback this damage will be permanent and the ecosystem will die’. Another later asks, “Do you know what block you might roll back to?”

Saul leans back and chuckles: “Nothing says decentralized like good, old-fashioned market manipulation”. I laugh before playing devil’s advocate: “but is it market manipulation when there are no regulations?” My comments are meant to be facetious, but Saul groans out a playful “nooooope” as he rolls me and my chair back to my workspace. One of our events coordinators asks us to explain. Saul’s voice booms with mock-Socratic pomp, “Let’s pretend that you leave 1 million dollars in an unlocked locker and someone comes and lights it on fire. Imagine they burn the locker full of cash. That money is gone. You don’t get to unburn it. But, if you invent Ethereum, apparently you get to, as Cindy Lauper might put it, turn back time, stop the blaze from engulfing your money, and you also get a bunch of new money that magically appears in the locker next door”.

In the excerpt above, my colleagues joke about the fact that the creator of Ethereum was able to successfully request that third-party cryptocurrency exchanges, which operate similar to unregulated, private banks, “stop trading” following the DAO hack. In doing so, Ethereum insiders were able to slow down time on the blockchain by interrupting and preventing financial trades impacting Ethereum’s network and token price from occurring. Buterin and others’ attempt to direct market activities demonstrates the plasticity of blockchain time and how software remains susceptible to attempts by individuals to ‘cast the present’ towards a desired future outcome (Kitchin 2019, p. 784). The hard fork rolled back the blockchain to a prior state, but it also rolled back the market for Ethereum tokens and, by extension, the potential for capital accumulation and profit that would have otherwise been lost due to the hack. Indeed, under conventional financial market conditions, firms do not have the single-handed ability to interrupt and overturn crises in the same way Buterin and other cryptocurrency insiders were able to accomplish by halting all Ethereum trading and rolling back the network to a state predating the hack. In fiat financial markets, capital either deteriorates or depreciates during a correction or crisis, but blockchain hard forks enable real-time market manipulation. The request to halt trading activities during the DAO hack also exposes how not everyone ‘lives in the same rhythm, in the same accelerated cadences’ (Guattari 2011, p. 109) and that, even in peer-to-peer economies, ‘the control of time is thoroughly enmeshed with the dynamics of power’ (Wajcman and Dodd 2015, p. 3).

The above memory also demonstrates the propensity for dominant rhythms, in this case the everyday temporalities of cryptocurrency trading, to assimilate resistant

rhythms (Edensor 2010). The DAO hack presented a disjuncture, or arrhythmia, from the normative rhythms of capital circulation, and the call to halt any ETH trading during the exploit can be read as an attempt to re-inscribe regulatory rhythms of the cryptocurrency market (Edensor 2010). This sort of rhythmic assimilation of arrhythmias exposes, as Edensor (2010) explains, how ‘capital is ever-ready to instantiate new forms of temporal regulation’ (p. 12).

Blockchain polyrhythms

27 July 2016

“Wait, come again? ... How is that possible?” Ron, a newcomer to this cryptocurrency meetup, frowns as Pierre, a programmer, takes out a pen and draws a line on a bar napkin: “Look, you know how the blockchain works, yeah? What happened is there was a hard fork of the blockchain to revert all the events on the network, or the state, to *before* the DAO hack. It undoes the exploit and, with it, removes evidence of the lost funds from the blockchain. Because of the rollback, all the money that was lost because of the DAO hack has been returned to investors on the version of Ethereum that was hard forked”. He then traces a circle over the drawing, over and over, stating: “there’s this other thing to consider. Some miners are still working on the original Ethereum blockchain. The one that didn’t undo the exploit, which means there are now two Ethereum networks. Any ETH you had before the fork, yeah, well now you have the same amount on the unforked version of Ethereum”. Pierre adds a branch to the line in his drawing and Ron leans over as he asks a follow up question: “Hold on a sec. There’s another Ethereum blockchain? Like a pre-forked network?” Pierre nods with a “yup”. Ron looks at me and the others at our table with a furrowed brow. He continues: “So the fork just doubles my coins? Can I spend the cloned ETH?” Pierre shakes his head and puts his hands up in a halting motion as he

responds: “Yeah, you can for sure spend it. But be careful. If you send it from one Ethereum to the other, you can end up burning coins and then your money will be gone forever. You have to separate your different Ethers first and only use the right version of the coins on the right blockchain. ETH to Ethereum and ETC to Ethereum Classic. Check the subreddit”.

In the memory above, local meetup attendees discuss the continued existence of Ethereum’s original blockchain, the replication of the Ethereum network, and tokens resulting from the hard fork. The emergence of two different versions of Ethereum’s blockchain, each with its own currency, illustrates how, even on a blockchain, time has no *a priori* ‘self-identity’ and ‘continually differs from itself’ (Grosz 2004, p. 249). The hard fork generated polyrhythms, or multiple disharmonious conditions for Ethereum to co-exist (Meadows 2010). Blockchain polyrhythms emerging from the hard fork impacted flows of cryptocurrency capital, doubling the supply of existing tokens along with the networks they circulated in and through, while instantiating an entirely new cryptocurrency network for capital accumulation. Pierre’s warning to Ron about spending his ETH on the correct version of the blockchain illustrates the interdependence of blockchain polyrhythms: ETH transactions operate alongside and in relation to the Ethereum Classic network and the inaccurate execution of code to spend one token on the wrong network can cause financial loss. Polyrhythms arising from the Ethereum hard fork demonstrate the potential harm culminating from algorithmic processes that cause collisions between two spacetimeatterings (Barad 2011).

Uneven geographies of arrhythmic algorhythms

20 July 2016

Our boss calls everyone to attention for our morning scrum: “OK, Will. Update. What’s going on?” Will, who looks like he’s been working around the clock since the fork, is visibly upset as he offers a summary of our users’ most pressing issue: “A lot of people are losing their funds because they don’t know how to split their Ethereum and Ethereum Classic tokens. They’re sending their crypto to the wrong fork or chain or whatever. I’ve got so many open tickets. I’m telling people to wait for our tool or to use the splitter contract from the Ethereum post. But, honestly, I don’t think most people are going to know how to do that and I think a lot of people want to dump their holdings, both versions of Ethereum, because they’re afraid the price will keep dropping”.

15 July 2017

This meetup is dragging on. It’s already 11pm. I try to cover a yawn, but nothing escapes Max, a self-described “whale” – he is always quick to remind us that he holds millions in cryptocurrency. “You tired already?”, he asks me with raised eyebrows. I nod as I suppress a second yawn, an aftershock of the first one. Max has been mining Ethereum since the network went live, but he’s currently focused on rolling a joint the circumference of my thumb. He extends the joint my way I shake my head to decline. Even though he hasn’t lit it yet, I feel my lungs constrict, my body threatening an asthma attack. He nods, lights up, exhales, and continues: “I’m convinced the exchanges didn’t take Ethereum Classic seriously. Or maybe they didn’t anticipate it. All I know is that I saw that shit coming a mile away and thought to myself: ‘is it theft if these assholes can participate in insider trading with no consequences? Why can’t I take advantage of this clusterfuck of a market?’” He takes another toke and holds his breath while confessing: “So, I did”.

Don, another Ethereum Classic miner, shares his experience following the hard fork: “That shit was nuts. A bunch of my buddies and I decided to mine on the old chain in the days right after the fork. There was some chatter that it was super slow at first and obviously not worth much, but we started once the difficulty adjusted because the hashrate on ETC was so much lower. It paid off. Not much, but it paid!” Max laughs and the two men high five as he passes the joint to Jonah, a self-described cryptocurrency consultant. Jonah nods aggressively as his chest and cheeks inflate with smoke. Between tokes, he admits that he also profited from the hard fork: “I still don’t like thinking about the fork ... I won’t lie and say that ‘oh, I didn’t take advantage of it’. I did some smart trading with my ETC and it ended up making, not to sound arrogant, but I did manage to come out with a significant amount of money”.

Both excerpts in this section reveal code’s ability to instantiate arrhythmias, or ‘discordant’ temporalities, on a blockchain (Lefebvre 2004, p.16). The Ethereum hard fork duplicated all cryptocurrency mined on the legacy network, yet these replicated tokens were not immediately evident or available to non-technical users lacking the technical ability to access or use duplicated tokens. Arrhythmia, in this case, illustrates how machinic processes can actualize what Kitchin (2019, p. 776) calls ‘code/spacetime’, where time becomes different spaces for different people, and produces uneven geographies. In the first excerpt, my colleague describes how the blockchain hard fork caused financial loss to Ethereum token holders unfamiliar or unwilling to split their own Ethereum tokens into the respective Ethereum and Ethereum Classic coins. Users lacking the knowledge to split their own coins and spend them appropriately expose specific instances where, even amidst supposed early adopters of

“disruptive” technologies, the application and distribution of information and communication technologies remains an ‘intensely uneven process’ (Graham 2002, p. 33). Meanwhile, my acquaintances in the second excerpt were savvy users, or what Kitchin (2019, p. 779) following Crang (2007) might consider “‘faster” and more temporally flexible subjects’. Indeed, Max, Don, and Jonah describe how their ability to respond quickly to the hard fork and keep mining on the legacy blockchain enabled them to profit from the event. In both memories reproduced above, the ‘timed and protocol-driven orchestration’ of the Ethereum hard fork created alternative and indeed opposing geographies for cryptocurrency capital to circulate (Miyazaki 2012).

More forks, more temporal (in)consistencies

7 September 2016

It’s been a few weeks since Madison and I spoke. Neither of us work at the startup anymore. After catching up, The DAO comes up. I tell Madison how I still can’t process the absurdity of the DAO, the hype, the exploit, and the hard fork. “It’s like science fiction, isn’t it?”, she asks. “Part of me wishes that it didn’t implode the way it did. I still think DAOs, not the DAO, but the idea ... I think it’s revolutionary ... Sure, sure, you’ll always have the douche-bag VCs and Silicon Valley bros. They’re just using these technologies because they see the profit in being first mover, creating the conditions of these new markets, or they know how to deploy these systems, take advantage of them. But it doesn’t have to be that way. There are progressive people, artists, writers, I don’t know, us, for example, who are learning about blockchain and re-commoning of the internet. DAOs and blockchain, they can be developed for different use cases that promote democracy. Empowering people. Blockchain’s value is defined by how you use the tech. I’m kind of shocked more people don’t hard fork. Ethereum just proved that you can totally do it

and it results in a new mode of value creation, an entirely new ecosystem of ideas, projects, consumption. Anything. I don't know why people don't just fork Bitcoin and make a killing on the coins from the new blockchain. Or, if you wanted to be revolutionary, you could hard fork Bitcoin or Ethereum, but write a protocol that automatically destroys every tenth coin mined. That would be pretty funny, wouldn't it? Really stick it to all the crypto-jerks". I confess that I hadn't even thought of the possibilities. Madison and I part ways after our chat and I go back to transcribing interviews.

In the four or so years following the conversation presented above, I often reflected on Madison's comments. After going on parental leave in October 2016, I watched with distant interest as discord within the bitcoin community surrounding the network's capacity to scale continued to mount, an issue that has dominated many discussions within the community for years. Catalyzed by damning critiques of bitcoin (see Hearn 2016), the community spent years grappling over design considerations surrounding the block size, which among other things limits the speed of a cryptocurrency's network. The block size is an important component of bitcoin's blockchain because, simply put, it constrains the pace of time on a blockchain or, in bitcoin's case, the volume, speed, and cost of processing transactions on the network.

A little more than a year after the Ethereum hard fork, the bitcoin block size issue would result in another hard fork. On 1 August 2017, a prominent group of bitcoin "big blockers" committed to raising the block size of bitcoin's network and speeding up transaction processing (among other goals) hard forked the network to create bitcoin Cash (BCH). Bitcoin Cash soon drew investors who saw yet another opportunity for speculative and more or less unregulated financial trading. It also attracted disgruntled Bitcoin users who saw BCH as a functional alternative to the original bitcoin network

since transaction took substantially less time to process on Bitcoin Cash's blockchain. In any case, it generated another timeline and version of Bitcoin's network.

Unlike the Ethereum hard fork, the Bitcoin Cash fork was not organized in response to an exploit. The Bitcoin Cash hard fork heightened already elevated tensions by splitting Bitcoin's blockchain, and generating its own token (BCH), secondary markets, and community. To further confound matters, Bitcoin Cash would undergo its own hard fork in November of 2018, splitting the Bitcoin Cash network into two additional chronologies, each with its own distinct network for mining and trading.

In the wake of the 2017 Bitcoin Cash hard fork, a number of other hard forks took place, such as Bitcoin Gold, SuperBitcoin, and Bitcoin Clashic (to name but a few) (Jenkinson 2018). Despite project websites that claimed to be deploying a different version of the Bitcoin protocol under the guise of increased access, network speed, scalability, or to promote some alternative vision or mission statement, most forks created alternate versions of the bitcoin network to duplicate existing cryptocurrency tokens onto the newly instantiated blockchains, creating 'economic value out of thin air' (DuPont 2018, p. 173; see also Scott 2016 for a discussion of speculative value and altcoins). Similar to the Ethereum/Ethereum Classic example, hard forks created the conditions for new chronologies of cryptocurrency networks to become possible, while also generating new economic instruments through the duplication of unregulated, peer-to-peer currencies. Blockchain hard forks also confuse cryptocurrency users, making it difficult to keep track of forked coins or follow the pace of existing and new crypto-markets.

The continued use of hard forks on blockchains opens up numerous questions about the proliferation of cryptocurrencies, and the danger of decentralized autonomous societies to, as Garrod (2016, p. 74) puts it, accelerate the creation of a 'world subsumed by exchange-relations'. Indeed, there is no denying that algorithms, especially as they emerge through hard forked blockchains, have the capacity to reconfigure the space-time compression and distancing of capital to various, uneven ends and with the potential to create arrhythmias that become pathological (Kitchin 2019; Lefebvre 2004). Nevertheless, the rise of Bitcoin, Ethereum, and other crypto-assets (e.g., DeFi) offer entrypoints into wider discussions about algorithmic politics, and the temporalities of 'on-demand' economies (Kitchin 2019; Cockayne 2016).

Conclusion

In this article, I argue that blockchain hard forks can instruct geographers on some of the ways algorithms, or the time-based processes organized and enacted through code, can alter and spatialize time. An examination of the 2016 Ethereum/Ethereum Classic hard fork and a brief review of subsequent hard forks of bitcoin's protocol reveal various code-produced temporal flows that can diverge, interact, and eventually find synchronicity for capital to accumulate and circulate in myriad ways. Algorithms of the 2016 Ethereum blockchain hard fork created a multiplicity of temporal realities that changed everything from cryptocurrency market dynamics, capital accumulation, circulation. The hard fork also altered ways cryptocurrency users understand and engage with time on the blockchain. Actions taken by the Ethereum community in the wake of the DAO hack assimilated existing rhythms of the Ethereum network, while the Ethereum hard fork generated new polyrhythms and arrhythmias to order

cryptocurrency finance. Technically proficient users actively manipulated time on Ethereum and Ethereum Classic's blockchains under the guise of saving investor funds from the DAO, preserving the network's integrity, or to take advantage of temporal disjunctures and overlaps for profit. Following the Ethereum hard fork, a variety of other blockchain hard forks occurred, creating a variety of inconsistent algorithms aimed at duplicating token supply for existing cryptocurrency and inflating the price of a given coin.

Accounts like those depicted in this article extend prior geographical research on the relationships between time and software, and how both reconfigure collective knowledge and memory about digital life (Elwood and Mitchell 2015). As scholarly interest in digital media, and specifically blockchains and cryptocurrencies, rises, placing greater emphasis on the multiplicity of code-organized time enables scholars to examine processes of algorithmic becoming, how they operate and who they marginalize (Elwood and Leszczynski 2018; Moss and Donovan 2018). On the topic of cryptocurrencies in particular, DuPont (2018, p. 173) asks, 'should we see cryptocurrencies and blockchains more generally as apparatuses for socio-technical experimentation in society?' Given the relative germinal state of qualitative research on cryptocurrencies and blockchains, DuPont's (2018) question undoubtedly warrants further reflection. One component of that work involves the continued and explicit excavation of cryptocurrency and blockchain algorithms, how peer-to-peer systems open up multiplicitous temporal possibilities, who accesses them, when, and to what effects. Who, for instance, gets to control block time (e.g., to stop trading), how do "fast/slow" subject positionings navigate peer-to-peer economies, and can more-than-

capital time become possible under these emerging “code/timespaces” (Crang 2007; Kitchin 2019)?

There also remains significant room for geographers and scholars in cognate disciplines to reflect upon the everyday use of and encounters with cryptocurrencies and its communities and how time on the blockchain, or hard forking as this article demonstrates, can function as a mechanism of value generation. Future research could take seriously the temporal relations shaping and transforming data as capital (Sadowski 2019), while also seeking to expose temporal flows of “techno-colonial solutionism” pervading blockchain-driven policy mobilities (Scott 2016). Geographers could also undertake algorithmy analysis to listen to gendered relations of blockchain and adjacent financial technologies and examine their capacity to accelerate capital accumulation, dispossess, cause violence, and normalize new forms of ‘*chronographic enslavement*’ (Guattari 2011, p. 113, original emphasis). In doing so, critical geographers could better analyse whether and/or how cryptocurrencies extend free-market thinking to generate new spaces of capital, and draw attention to the material impacts of space-time convergence and distancing (Scott 2016; Kitchin 2019). Alternatively, future critical research might uncover the emancipatory potential of self-organized and alternative digital forms of finance in order to determine whether or not cryptocurrencies and blockchain technology can cleave open actually-existing liberatory digital spaces, cultivate postcapitalist futures and, if they do, consider how they are ‘nullifying capitalistic refrains’ (Guattari 2011, p. 114; Elwood and Leszczynski 2018).

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Chapter 5

“Making blockchain real”: Regulatory discourses of blockchains as a smart, civic service

Abstract

Policymakers across Canada are considering the blockchain as a way to enable smart(er) governance. Despite the technology’s infancy, jurisdictions perceive smart tools as one of many ways to govern efficiently. Critical geographers, however, remain circumspect of datafication as a value-making process, and have traced myriad ways that data-driven technologies participate in the materialization of smart policy mobilities and governance. This article uses auto-ethnography to highlight discourses positioning blockchain technology as a data-driving and producing civic service. Empirical findings suggest that Canadian policymakers draw on entrepreneurial discourses of digital leadership, transparent data management, and digital empowerment to justify their plans in “making blockchain real.” These regulatory discourses promote datafication through blockchains as a way to improve government services.

Keywords: auto-ethnography; blockchain; datafication; smart governance

Introduction: Making blockchain real

A man to my right makes eye contact with me and leans left, presumably to chat. The keynote begins, preventing awkward small talk. Within moments, the speaker, Jack Markell, Delaware’s Governor, runs the audience through a long list of blockchain use cases. If we are to believe Markell, the blockchain, the technology underlying Bitcoin, will revolutionize government. It will improve civic service delivery, data collection, integrity, management, and empower individuals to control their own data. Markell’s hard sell on the ‘disruptive’ technology quickly turns into a sort of contrived press conference

for the Delaware Blockchain Initiative, a regulatory sandbox designed to attract blockchain ventures to the state. Markell's pitch impresses my neighbour, who leans over (again) and whispers: 'This is the next digital revolution. I bet in three years every government will be on the blockchain'.

I wrote the excerpt above following a keynote address at an international blockchain conference in New York City in 2016. I attended the conference as part of my doctoral fieldwork and employment at a blockchain start-up. The conference theme was "Making blockchain real", an apt slogan given Governor Markell's call for governments to legitimize the blockchain. A blockchain is a digital ledger that uses encryption to publish "blocks" of time-stamped data distributed across a network of users and first popularized by bitcoin. Despite hype surrounding Markell's keynote and announcement, the Delaware Blockchain Initiative stalled in 2018, less than two years following its launch, amidst fears it would cause revenue losses for industries operating in the state (Baker 2018).

Markell's keynote and sandbox illustrate an emerging trend of blockchains being used as smart tools for entrepreneurial governance. Jurisdictions around the world adopt the blockchain to enhance the digital capture and transformation of various attributes into data, or datafication, to become smart, unlock new investment pathways, and enhance efficiency. The use of data and digital technologies to bolster smart initiatives under the guise of innovation and entrepreneurial governance is by no means a novel phenomenon (see Barns 2016; Kitchin 2014a, 2014b; Dalton and Thatcher 2015). Yet, the trend of governments invoking bullish discourses about blockchains to achieve smartness appears to have only just made its debut (Hütten 2019). In Canada, policymakers have begun to initiate blockchain pilots to improve e-government services,

open data, and enable digital citizenship via personal data management (“The CBSA” n.d.; “Exploring” 2018).

Government blockchain use cases remain fledgling and experimental due to the technology’s relative infancy and its association with bitcoin, a stateless currency designed by “hacker-engineers” (Brekke 2020; Walch 2019). The literature on blockchains reflects this, with much of the critical qualitative scholarship emphasizing questions of power and politics, political economy, governance, and ideology (Crandall 2019; Käll 2018; Walch 2019; Zook and Blankenship 2018) as well as political ecology and the environment (Howson et al 2019; Lally, Kay, and Thatcher 2019). Recent contributions, such as Ølnes et al. (2017), call for more in-depth research into government blockchains.

In geography, current provocations on digital technologies emphasize the production of data towards universalism and as a form of colonialism (Milan and Treré 2019; Thatcher, Sullivan, and Mahmoudi 2016), capital (Sadowski 2019), and to inspire “fast policy” for government-led open data initiatives (Barns 2016; Barns et al. 2017). In light of these interventions and inspired by feminist approaches, I use auto-ethnography and intimate writing methods to interrogate discourses justifying blockchain adoption by and for governments. Excerpts from field journals supported by data collected through semi-structured interviews and participant observations reveal insights into some of the ways Canadian policymakers and regulatory technology lobbyists, or “regtech”, are making blockchain real. Specifically, governments rely on entrepreneurial discourses of leadership, transparency, and digital citizenship to substantiate blockchain adoption (Arner et al. 2016).

In what follows, I provide an overview of blockchain technology before reviewing geographical scholarship on smart technologies and datafication. Next, I discuss my methods and then present three entrepreneurial discourses from policymakers implementing blockchain technology towards smart governance in Canada: digital leadership, data transparency, and digital citizenship. Following a brief discussion detailing initial insights into actually existing blockchains, I conclude by suggesting future research trajectories on blockchains as smart policy mobilities.

Blockchains and the false promise of trust

The buzz around the blockchain persists in many policy circles, yet few agree on what a blockchain is (Ølne 2017; see also Hütten 2019). Caliskan (2020) alerts us to the definitional ambiguity of the term, noting the absence of the word “blockchain” from Nakamoto’s 2008 bitcoin whitepaper. As Caliskan (2020) explains, there is no singular blockchain but a diversity of blockchain topologies, many of them riffing off of bitcoin’s design.

Notwithstanding the term’s elasticity, a blockchain generally refers to software architecture that chronologically records “blocks” of tamper-resistant data transacted across a network of peers. Most blockchains rely on cryptographic hashes to ensure network security and make their “ledger” – the transaction record of those data blocks – more or less incorruptible (Tasca and Tessone 2019). Achieving immutability and securing the network are costly tasks, however, which is why blockchains tend to require energy intensive compute power or resource allocation (Howson et al. 2019). Computation committed to a blockchain ensures that data are recorded and replicated across the network in line with the protocol’s consensus rules while preventing network

failure. In many cases, a malicious actor would need to take control of at least 50% of the network by committing exorbitant compute power to override network rules, undermine a transaction or falsify the ledger (O'Dwyer 2018).

Bitcoin inspired a plethora of blockchain designs modifying rules surrounding everything from network architecture to consensus, centralization, permissions, and security (Ølnes et al. 2017). There are numerous ways to discuss blockchain topologies, with a number of debates persisting about whether certain topologies should be considered blockchains (Caliskan 2020; Ølnes et al. 2017; Tasca and Tessone 2019). I adapt Ølnes et al. (2017) and Daniels' (2018) frameworks to categorize blockchains across two general properties: open/closed and permissionless/permissioned (Table 5.1).

Table 5.1. Dominant blockchain topologies (adapted from Ølnes et al. 2017 and Daniels 2018).

	Permissioned	Permissionless
Open	Data access and transaction are unrestricted, but only select users can participate in the validation of data published to the blockchain (e.g., Ripple)	No restrictions on access to data, transactions, or the validation of the blockchain. Everyone can participate and subject to the same rules (e.g., bitcoin).
Closed	Data, transactions, and validation are regulated to by the owner (e.g., Hyperledger Fabric).	Anyone can run a node but there are restrictions surrounding access to data and network transactions (e.g., Holochain).

Open and permissionless blockchains, such as bitcoin, allow any user to participate on a network and read and write to its ledger (Caliskan 2020). Generally, open blockchains are designed using one-way cryptographic hashes to prevent individual users from updating or deleting data recorded onto the ledger (Tasca and Tessone 2019). Since there are no access restrictions to open and permissionless blockchains, encryption prevents malicious actors from falsifying or redacting data on the network. In practical terms, encryption provides insurance or removes the need to “trust” any network participants (O’Dwyer 2018).

Not all blockchains use cryptographic hashes or even blocks of data. Some closed and permissioned blockchains, often called distributed ledger technologies (DLTs), leverage the auditing capabilities of open blockchains to timestamp events and share this information with a variety of users with certain restrictions in place. Open, permissioned blockchains allow any user to view data, yet only approved users can validate network events. Conversely, closed blockchains include hierarchies by design: a central authority, a group or a consortium of predefined users that can restrict who can read and write and in some cases have the power to update or delete data. Closed blockchains rely on permissions to determine who is allowed to read, write, update, or override the ledger’s contents. Closed and permissioned blockchains delegate trust to one or more approved network actors. Meanwhile, the more nascent category of closed, permissionless blockchains relies on different architecture than more conventional blockchain topologies (Daniels 2018) (Table 5.1).

Blockchain topologies aside, encryption mediates how trust is delegated from ‘institutional actors in the system to the instrumental control of trust by the software’

(Swan and de Filippi 2017, p. 613). The blockchain's ability to delegate trust to humans writing code is a selling point for large corporations and governments seeking to increase data capture as well as automated workflows that minimize manual processes and dependencies. Governments perceive encryption as a form of trust over the control mechanisms surrounding data management and sharing.

Perceptions that the blockchain creates trust through code or encryption positions the technology as smart. As Käll (2018, p. 134) explains, encryption can 'produce locked connections' that facilitate control over objects and persons. If governments can design blockchains that programme their control over digital locks created by a blockchain-type protocol, then they can improve data management while retaining the power to restrict access based on programme requirements and legislation. Blockchain protocol design therefore determines how trust, and by extension power, is distributed on a network (Walch 2019).

Closed and permissioned protocols risk enhancing government and corporate control over data without necessarily mitigating against data security threats or data loss (Käll 2018). Many government blockchains buy into the concept of "algorithmic trust" (Swan and de Filippi 2017) even though most implementations are closed, permissioned, or blockchain-like in their architecture. Government blockchains, therefore, tend to delegate network authority to a closed group of participants across an organization or a consortium's servers, with many of these operating in proprietary environments. In addition, like all software, blockchains are subject to hacks, design limitations, and prone to centralization, exposing some of the unpredictable material effects of experimental technologies (Schneier 2019; Walch 2019).

Despite the risks outlined above, the blockchain's promise to render a tamper-proof record remains alluring to policymakers: it promises to digitize, organize, and, by extension, solve for the inefficiency and partiality of paper records. To institutions seeking to collect and leverage data as a strategic asset, a trustworthy and persistent timestamp of network events enhances analytical potential of, and engagement with, data for decision-making processes involving multiple partners (Barns et al. 2017). The supposed accessibility, shareability, and transparency of blockchained data bolster smart narratives that leverage the collection and management of reams of data to 'build stuff' or grow assets (Sadowski 2019, p. 7; see also Vanolo 2014).

There also exists an enduring perception that blockchain applications could increase government transparency and accountability and optimize data management (*The Economist*, 2015). Allam and Dhunny (2019, p. 89), for instance, argue that blockchains could encourage civic participation since, 'Big Data by the [sic] city stakeholders could be kept permanently and made accessible across networks of computers' (see also Muzammal, Qu, and Nasrulin 2019; Voto 2017; and Zyskind et al. 2015). Conversely, Ølnes et al. (2017) suggest that the benefits of blockchain technology have been exaggerated and highlight that minimal evidence supports claims that it could function as a general purpose technology. To better understand some of the assumptions underlying discourses of blockchains as potential smart services, I provide a brief overview of datafication in the next section.

Datafication and the blockchain

Recent scholarship in digital geographies considers datafication, or how data come into being (Sumartojo et al. 2016). The datafication of everyday life involves the

transformation of diverse attributes into digital data for subsequent analysis (Sumartojo et al. 2016; see also van Dijck 2014). Today, the digitization of bodies and everyday activities is a pervasive reality for many, but how datafication occurs and to what ends is itself a process characterized by difference and, in many settler contexts, exploitation (Milan and Treré 2019).

Geographers criticize datafication for its unabashed quantification of everyday life rooted in ‘an instrumentalist logic’ (Cinnamon 2019, p. 11). Techno-solutionist rationalities undergirding datafication presume quantified representations of the world will incite better ways to govern, accelerate innovation across industries, and lead to more robust research (van Dijck 2014). Datafication, however, is one component of larger sociotechnical assemblages that actively participates in knowledge production, commodifies bodies, and intensifies systems of oppression (Benjamin 2019; Noble 2018; Sumartojo et al. 2016). Historically, many datafying practices have been what Pasquale (2015, p. 8) calls ‘black boxed’, meaning that the ‘values and prerogatives encoded rules enact are hidden’. For corporations, black boxing software equals profits as businesses do not want to share industry secrets. For governments, the black box of code is often associated with dataveillance, breeding mistrust (Pasquale 2015). In response to such critiques, numerous governments are embarking on initiatives to open their data (Barns 2016; Kitchin et al. 2015).

The popularization of methods streamlining the collection and commodification of any conceivable data source exposes a “data imperative” (Sadowski 2019; see also Fourcade and Healy 2017). Data serves as a seductive policy tool for governments searching for ways to optimize service delivery and leverage the digitization of

information as a strategic asset. The concerted extraction, accumulation, and analysis of myriad data sources incites new governance models and economic possibilities. Decision-makers, for instance, seek to inject strategic policymaking with the perceived rigour and veracity of data in order to better ‘conduct management by measurement’ (Kitchin et al. 2015, p. 14). This drive for data-driven management extends to open data policies focused on the creation of new data-reliant services and markets (Barns 2016). The “data imperative”, whether through increased data collection, commodification, or the opening of datasets, participates in wider smart policy mobilities aimed at positioning governments as ‘technologically advanced, green and economically attractive’ (Vanolo 2014, p. 889).

There is extensive scholarship that is critical of “smart” technologies and policies leveraging data collection as a means to improve civic services and government processes across different jurisdictional scales (Barns 2016; Barns et al. 2017; Kitchin 2014b; Kitchin et al. 2015; Vanolo 2014). In geography, much of this literature interrogates how data and technology reinforce ‘market-led solutions’ to various forms of citizenship and governance (Cardullo and Kitchin 2019, p. 2; Shelton et al. 2015; Kitchin 2014b). One emerging technology influencing smart policy mobilities involves the promotion, adoption, or use of blockchains by governments to increase datafication under the guise of service delivery, thereby justifying the adoption of data-producing and driving policy tools. In the next section, I offer a brief overview of my methods before discussing three regulatory discourses promoting blockchains as a means to smart(er) governance.

Methods

Between September 2015 and March 2018, I conducted doctoral fieldwork by using auto-ethnography, semi-structured interviews, and participant observation. I chose Toronto as the primary fieldsite because it is the epicentre for blockchain and smart-city initiatives in Canada (Wylie 2020). My employment and participation in Toronto's cryptocurrency and blockchain industry granted me direct access to blockchain "insiders" and cryptocurrency "thought leaders", which facilitated formal recruitment of interview participants. Acquaintances and colleagues served as gatekeepers, introducing me to the "who's who" of Toronto's blockchain communities, who were often excited to spend hours discussing blockchains. My personal and professional relationships with blockchain technologists afforded early and detailed access to emerging blockchain initiatives, industry happenings, and policy and technical discussions.

Despite my privileged position in the blockchain community, I resisted the blockchain hypecycle by divesting myself of any cryptocurrency profits. I kept my employment in the industry and research separate. I never recruited research participants while at work and avoided discussing my research at the office. When colleagues, supervisors, or stakeholders enquired about participating in my research project, I would discuss the matter with my boss, and only follow up on a request outside of the workplace and work hours, with my university email address. Still, I struggled to delimit my personal, professional, and research positions, leading me to reflect on my partiality as a researcher working in "the field" and my research design. The data presented are not solely bounded by defined events such as interviews and

journal notes, but porous to other, 'minor gestures' such as informal encounters, and autoethnographic reflections (Nordstrom 2018, p. 215).

The use of auto-ethnography acknowledges that researchers are not disembodied producers of universal knowledge. Rather, auto-methods reveal how written expressions of researcher experiences, by writing 'our own and other's lives', can serve as data and analysis (Moss and Besio 2019, p. 314). Auto-methods build upon feminist traditions that highlight the partiality, positionality, embodiment, and experience of the researcher, all the while refusing positivist approaches to research that essentialize truths (Jackson and Mazzei 2013; Moss and Besio 2019). Instead, auto-ethnographic writing depicts moments that expose the embodied realities of specific research, work, and personal encounters. These reflections reveal the subtle but complex ways research activities are enmeshed in and impacted by a diversity of power relations, apparatuses, and institutions (Moss and Besio 2019).

In addition to auto-methods, I use 36 of the 74 semi-structured interviews I conducted for my doctoral research project. These interviews were in person as well as over the phone or internet, with each interview lasting between thirty minutes to just over six hours. Interviews focused on blockchain regulations or government initiatives across a variety of jurisdictions. Participants ranged from cryptocurrency and blockchain "thought leaders", Chief Executive Officers (CEOs), Chief Technology Officers, computer programmers contributing to cryptocurrency or blockchain projects, and entrepreneurs. I sought informed and explicit consent for interviews in line with my institution's research board. With consent, I audio-recorded interviews with a voice-recorder or an air-gapped phone and manually transcribed recordings.

The blockchain industry remains small and most people, if they do not know each other, know of each other. Sometimes relationships are acrimonious (Sotoudehnia 2019). Many individuals working on blockchain projects also have competing professional and financial interests, and may be bound to non-disclosure agreements. To reduce risks, I use obfuscation techniques to anonymize interlocutors, including aliases and modified details surrounding research encounters (Hopkins 1993).

Becoming a leader: Government blockchains and smart entrepreneurialism

I meet Randy, a blockchain enthusiast working for a Canadian federal agency at a coffee shop. We sit down with our hot chocolates. Randy asks me when I got “into blockchain”. Before I can respond, he tells me that he’s an early investor in “crypto”. I nod politely as he qualifies his blockchain expertise and tells me that he’s working on a blockchain project at work. I ask him about the blockchain use cases federal agencies are exploring. Randy mentions auditing and how blockchains could help agents track work, or improve workflows. I ask him a few more questions – are they building on Ethereum, or using some kind of enterprise solution? He shakes his head and says: “I’m not convinced it matters. If we’re the first ones out of the gate ... that’ll get the ball rolling. Have you heard of just-in-time production ... where you get all the pieces built independently and put them together right at the end? I think of that – get the decision, figure out business procedures, and then worry about the technology. That part already exists. Satoshi invented it. It’s called a blockchain”.

Like the above conversation with Randy, many discussions about blockchains with policymakers remained abstract but underscored blockchain adoption as a means to demonstrate digital leadership. The blockchain’s ability to enhance data and analytics, such as Randy’s emphasis on auditing and improved workflows capabilities, was often

assumed as sufficient justification to lead blockchain development in government.

Being 'first to policy' with a blockchain, as one manager working for the Province of Ontario told me, held strategic benefits for government seeking to partner with businesses in the technology sector:

I'd say this is even more the case with blockchain ... they're looking to talk to policymakers who understand their business. Jurisdictions who have done the research, and are hatching a plan to help with adoption ... They don't want to burn months or, in government time, years explaining how hashing works or trying to show them the writing on the wall ... we either jump aboard now or get left behind.

The participant's emphasis to 'jump aboard' the blockchain reflects the entrepreneurial logics undergirding government adoption and promotion of data-producing and driving technologies (Barns 2016).

Another public servant working on a health records blockchain initiative for a Canadian jurisdiction noted the perceived political benefits of decision-makers positioning themselves as blockchain leaders:

Once a blockchain gets green lit and ... people have this "aha" moment ... now we get invited to brief people, give talks, lectures. We become experts. Our policies gain attention. Other departments and governments can use some of our work as a template.

The participant's suggestion that blockchain leaders can create a 'template' for reuse by other governments reveals some of the ways blockchains are enlisted as 'technological transitions' to smarter governance grounded in desires to access, enhance, and share data (Vanolo 2014, p. 894; Kitchin 2014b).

Meanwhile, a CEO consulting with governments on the potential of blockchains explained that those touting the virtues of blockchains and cryptocurrencies stand to gain control over the regulatory landscape by encouraging early policy work:

My goal ... is to start working with policymakers to make plans to drive Canada forward with these disruptive technologies, and how do we make it a friendly environment to businesses ... To educate policymakers to the potential benefits to the country to learn how these technologies create jobs, create new sectors. How, if they put harsh regulations without fully understanding the risks or how these regulations can harm us ... And this is how we get ahead. If we do this, we'll be leaders of the world.

The focus on leading the establishment of blockchain-friendly regulations demonstrates a form of smart entrepreneurialism where governments take on facilitation roles for the creation of 'new data-services markets' (Barns 2016, p. 567). In the context of the blockchain industry, facilitation becomes even more ambiguous since what those new markets are or could become remains mostly undefined at present. The lack of clear and consistent regulations across jurisdictional boundaries also incites concerns surrounding any datafication and data-sharing emerging from would-be blockchains, prompting questions about control and management of data in relation to interjurisdictional data persistence and privacy (Käll 2018).

Regulatory "leadership" of blockchain implementations also draws upon smart cities discourses, highlighting a 'spirit of innovation' dependent on a jurisdiction and economy's 'ability to transform' (Vanolo 2014, p. 887). This transformation, through 'emergent policy models' and their mobilities, legitimizes largely untested smart technologies (Barns et al. 2017, p. 25). In the case of blockchain technology, these

smart mobilities also scale down to the individual who, through their evangelization of the technology or association with a government blockchain initiative, gains a reputation as a subject matter expert. Yet these reputations can result in the adoption of blockchains that fundamentally alter how attributes are quantified and digitized, further entrenching quantification as a ‘part of everyday life and its lived environments’ (Sumartojo et al. 2016, p. 35).

Discourses surrounding blockchain leadership reveal how diverse corporate logics embed themselves into smart governance to increase the production of data (Kitchin 2014b). Interlocutors argued that blockchain-friendly policy development would nurture a fledgling sector and encourage its establishment. Rather than only attracting large international vendors, the promotion of blockchains by and for government hint at some of the ways that the technology could open up new markets for largely unregulated new entrants. While this currently does not result in vendor monopoly or ‘a corporate path dependency’, it extends existing questions surrounding what a “technological lock-in” might look like as blockchains become prominent policy tools (Kitchin 2014b, p. 10). It also incites questions surrounding accountability over any datasets hosted on vendor-built and government hosted blockchains.

Becoming transparent: Blockchains and open data

I’m at a regtech meetup and an “eco” blockchain startup is explaining their work with a variety of government partners, the United Nations (UN), corporations, and the ‘unbanked’ to combat climate change. The CEO explains the blockchain’s potential: “to improve transparency and traceability of emissions ... we can now accurately and in real-time monitor where and when emissions occur ... improving emissions programs, allowing data-

sharing, which can then be combined for further analysis”. His presentation ends and the moderator asks the room for questions. One man asks the speaker how he managed to get government buy-in for disruptive technology, noting that governments and blockchains don’t seem like “natural bedfellows”. The CEO responds: “Governments want to improve their processes but don’t have the capacity to explore cutting-edge tech like industry does. We ... ask them what their needs are. They need to track goods, audit logs for which agent spoke to a client, prevent fraud, reduce energy emissions. Be accountable to their constituents. Build public trust by making the data they collect citizen-facing. We have a solution for all of that. Maybe it’s blockchain to collect new data, maybe you blockchain the data you already have to show the world, maybe it’s a bit of both”.

Blockchain solutions for ‘regtech’ are often, as Howson et al. (2019, p. 6) argue, sold as both ‘post-political’ and ‘entirely technical’ solutions to sustainability. In a number of encounters, blockchains were perceived as data-driven and data-producing technologies that governments and corporations could share back with constituents, with open datasets serving as “public” services or products (Kitchin 2014a; see also Gurstein 2013). Specifically, distributed ledgers are promoted as tools that enable data collection previously impossible by government actors, or optimize existing collection practices. In both cases, government blockchain applications promise to increase the veracity of data collected. An emphasis on the “accuracy” of data collected through a blockchain reveals persisting assumptions by decision-makers and industry that data have the capacity to quantify reality objectively (Kitchin 2014a). As one former Canadian decision-maker I spoke to explained,

Government needs to know what data are. I have to trust the number or statistic I’m given. This [blockchain] technology enables us to transform

questions into accurate data: When did we collect this? Where? Is it a source of truth? Are there others? Ideally, we should be able to trust our sources. In my experience, that's not always the case. If I can't trust the data, how can I use it to make a policy-decision? How can I share that data with the public and expect them to trust my policies?

The presumed accuracy of data collected using blockchain technology also threads through discussions about the technology's potential to open data to the "public". One manager working for the Canadian Federal Government explained the perceived benefits of blockchains to open data already collected by the government:

Think of all the data we ask of citizens ... maybe it's personal, maybe it's business ... in some cases, it's probably a bit of column A and column B ... we take in a lot of data and you know how we store it? Maybe Excel, if we're lucky. So maybe data from column A are in a spreadsheet, it gets sent around, and then nothing happens because it turns out that the data for column B isn't even digital. So you can't compile a full dataset. That's a hypothetical example but we see this sort of thing all the time. Imagine if we could take that data, train an AI with it, and push it to a blockchain ... Everyone in government could see it ... Shape policy with data. Farmers, businesses, some fourth grader writing a school report could use the data. And, hey, as a result, the public are engaged. They want to contribute, improve the data.

Discussions surrounding blockchains as a mechanism to open data and encourage government accountability underscore how data-driven technologies are woven into wider digital strategies that seek to increase and improve public engagement (Barns 2016; Barns et al. 2017). Interlocutors often described the blockchain's potential to expose data otherwise "obfuscated" or "black boxed" (Pasquale 2015; see also Dalton

and Thatcher 2015) to a variety of actors. Organizing and opening government-collected data with a blockchain, as the interlocutor above exemplifies, is perceived to improve a variety of downstream reuses of data (Kitchin 2014a). The blockchain's promise to open, share, and reuse data demonstrates some of the ways datafication could be used to, as Vanolo (2014, p. 884) puts it, 'naturalise and justify new assets for the circulation of capital and its rationalities within cities'.

Becoming responsible: Blockchain and digital citizenship

I'm at a blockchain talk on decentralized identifiers, or what many people might call self-sovereign identities. The speaker, an individual working on an e-identity program in Ontario, is making the case to put our driver's licenses and passports on a blockchain. Decentralizing identity with blockchain technology, he argues, will increase services to people at the margins of society, enable seamless movement across jurisdictions (specifically between provinces and territories, and across provincial and federal services) while also giving end-users control over their personal data. Governments, the speaker tells the crowd, shouldn't be responsible for our personal data and the blockchain solves this: "with blockchain, individuals hold the keys to their data, putting them in control of their own privacy and identity".

Self-sovereign identity blockchains were nearly always invoked as a public service promising to create digital forms of citizenship or belonging: increasing mobility, optimizing transnational e-government services and empowering marginalized populations (Beduschi 2019; see also Calzada 2018). Interlocutors discussed the ability to control personal data with blockchains as an assumed, universal benefit to improve public engagement. Yet the above excerpt reveals some of the complications surrounding the use of datafied attributes to encourage smart governance. In particular,

it raises questions about how personhood is datafied and managed on the blockchain, and by whom. The responsabilization of identity management as illustrated in the excerpt above injects what Vanolo (2014, p. 893) calls a 'moral obligation' for individuals to behave according to a wider smart project.

Government blockchain services, such as e-identity schemes, often place the onus on end-users to manage their own data. This, Beduschi (2019) underlines, introduces security challenges resulting from hacking or could result in data loss through user error or mismanagement. Consequently, end-users risk losing access to their government services including proof of identity since access to a blockchain is mediated through private keys, which function as passwords. There is no recovery for a lost or forgotten private key, further placing the onus onto end-users to maintain and secure individual access to government services.

Datafying personal and bodily attributes and storing them on an immutable ledger also introduces a variety of privacy and geosurveillance concerns (Swanlund and Schuurman 2018). Swanlund and Schuurman (2018, p. 933) caution that second-generation biometrics 'work on the body itself rather than some other carried technology'. This, they argue, can increase the 'legibility of subjects' (Swanlund and Schuurman 2018, p. 933).

Datafying identity on a blockchain can also elide some of the affective realities of data while extending solutionist narratives that position data as always already complete (Sumartojo et al. 2016). As Beduschi (2019) underscores, identity blockchain use cases may provide individuals with access and autonomy over their personal data, but it also opens up new methods for discrimination and exclusion. Datafied identities on a

blockchain can, for instance, facilitate the identification of vulnerable populations, rendering discrimination easier to carry out.

In fact, questions surrounding datafication and wider epistemic injustices associated with the blockchain were often dismissed (Milan and Treré 2019). During a meeting with a firm working on a blockchain initiative for personal health records with an undisclosed Canadian subnational government, the company's CEO asserted that:

there is no risk to the public. On the contrary, it removes existing dependencies. Government can organize files that are currently god knows where – things go missing, you fill out the same forms every time you use the system, and practitioners don't have access to a comprehensive record of your health. And neither do you as the patient ... Blockchains help us design permissions on specific attributes of an individual's identity – everyone can see what they need to see: you see your records through your smartphone and so can the doctor, the pharmacist can see that you need medicine without having to know why, the nurse can tell if you've been triaged but not where you live. It removes ambiguity from healthcare. You can set it up so that each stakeholder in the health system only sees what they should see ... your privacy is protected.

When pressing for details surrounding how someone without access to a digital device or internet might benefit from having their medical records on a blockchain, the CEO laughed, claiming that 'even people in third world countries have smartphones'. Indeed, in conversation with a government representative working on decentralized identifiers for a European state about the inherent limits to putting passports on a blockchain, one interlocutor asserted: 'that's not really a real criticism. It's not 1999'. This, despite the fact that many proposed blockchain applications in government do in fact require

access to a smart device, internet, and some degree of technological proficiency.

Yet the gaps between those with access to and literacy of information and communication technologies, or the digital divides, extend beyond questions of 'network readiness' (Howard, Busch, and Sheets 2010). Recent contributions to the literature emphasize different axes of inaccessibility, ranging from access to infrastructure and mobile computing to race, gender, age, literacy, and marginalization more generally (Warf, 2019). According to the Canadian Radio-television Communications Commission (CRTC) (2019), 88% of Canadians have access to mobile computing, but this number elides access issues for Indigenous populations, rural locations, and other socio-economic indicators.

The outright dismissal of the blockchain's limitation to solve a public service delivery problem such as healthcare records management, or a policy problem surrounding identity, for instance, points to the blockchain's capacity to reproduce existing forms of algorithmic exclusion and intensify power relations instead of solving public policy problems (Milan and Treré 2019).

Becoming real: Actually existing blockchains as civic services

The above discourses reveal datafication as one means to justify blockchain adoption in government. In practice, however, government blockchain initiatives have varied results. In this section, and following Shelton et al.'s (2015) call to look at place-specific smart policy implementations, I provide a brief overview of government blockchain initiatives before offering concluding remarks. Unlike the findings above, the examples below extend beyond a Canadian policy context. The implementations below highlight yet more ways that code, through the blockchain, can put entrepreneurial tactics to work.

Others expose wide gaps between the intended goals of smart governance, regtech, or enhanced datafication, and how actual blockchain implementations operate on the ground.

The limits to blockchain leadership

The government of Malta created a suite of regulations to become the world's 'blockchain island', a regulatory friendly jurisdiction for crypto investors (Hamacher 2019). Malta's strategy initially drew a large number of cryptocurrency and blockchain companies. The influx of business created an overwhelming physical presence on the island, impeding the delivery of services to residents and turning Malta into a victim of its own entrepreneurial success.

In addition, Malta is home to the custodial cryptocurrency exchange Binance, a sort of unregulated cryptocurrency bank now infamous for being the target of hacks and leaking user data (De 2019). The bad press and potential fallout of a blockchain hack undermines Malta's supposed position as a blockchain leader. It also surfaces risks of datafication, in this case potentially compromising user data, and the costs associated with being "first to policy". In fact, in September 2019, Maltese financial regulators began actively monitoring exchanges and other blockchain ventures in response to corruption claims (Hamacher 2019). Enhanced regulatory requirements are causing crypto and blockchain investors to leave the island for more business-friendly jurisdictions.

Blockchain and transparency

In practice, government blockchains attempting to achieve transparency introduce

operational risks. In 2017, the National Research Council of Canada announced Catena, a blockchain explorer using Ethereum's network and hosted on the Inter Planetary File System (IPFS) to publish research dollars granted to institutions (National Research Council of Canada 2018). The only data exposed through Catena includes the funding distributed by the council for the first three quarters of 2016, which is ostensibly of limited use to anyone. As of 2020, Catena appears unmaintained, with the last contribution posted to GitHub in April 2018.

Catena raises questions about the costs of maintaining smartness and datafication. What, for instance, are the sustainment paths and value propositions of blockchain technologies developed by governments? Without dedicated teams to maintain implementations, initiatives such as Catena are prone to recede with the next ebb of the blockchain hype cycle, leaving government agencies with stranded data assets. If every government agency spins up a blockchain that is subsequently abandoned, claims to efficient data management and real-time audit logging fall to the figurative wayside. Indeed, unmaintained blockchains such as Catena do not appear to achieve smart governance goals, or leverage data to enhance the delivery of government services. Instead, they threaten to increase bureaucratic bloat by way of abandoned software and datasets, resulting in foregone costs.

Conversely, some government blockchain initiatives are leveraging the technology's encryption to protect data sources and increase control over which data to open. The United Kingdom's ARCHANGEL leverages a blockchain implementation to prevent digital tampering and protect video files in the National Archives from being transformed into deep fakes ("ARCHANGEL" 2018). In the ARCHANGEL example, the

blockchain serves to protect data integrity instead of merely opening it, demonstrating some of the benefits of improved data publishing.

Interrogating digital citizenship

Estonia's e-ID initiative is cited as a successful application of blockchain technology to enable smart, digital governance (e-Estonia, n.d.). The project is part of a wider digital government transformation to create an 'efficient, secure and transparent ecosystem where 99% of governmental services are online' (e-Estonia, n.d.). The solution includes four digital identity services, including a smart-ID, to provide citizens with a way to 'safely identify themselves and use e-services' (e-Estonia, n.d.).

The initiative, however, has a couple of limitations that warrant exploration. In 2017, for instance, a cryptography researcher identified a security vulnerability that could theoretically allow hackers to crack the cryptography used and compromise user data (e-Estonia, n.d.). The vulnerability calls into question uncritical claims that the blockchain, or encryption, inherently provides data protections to end users or that leveraging such technologies will eliminate risks of data breaches or leaks. Incidents like e-Estonia's also expose the limits of smart governance in action, where data management tools do not always work as intended and, in fact, create vectors to exploit users associated with datafied attributes.

In addition, Estonia e-ID does not actually use what most would call a blockchain. Rather, it merely relies on cryptographic hashes to link 'data items' or, simply put, it uses *some* components of a blockchain (Kivimäki 2018). Estonia's e-ID blockchain-*like* topology recalls ongoing debates about the definitional porosity of a blockchain and serve as a reminder that obfuscation by way of incomprehensibility is also a form of

black boxing. Estonia's blockchain-like e-ID also raises questions surrounding the usefulness of blockchains for government purposes. One wonders why a blockchain is even needed.

Conclusion

This article explored some of the ways blockchain technology is being promoted as a smart, public service in Canadian policy and regtech circles. Blockchains are being endorsed by government and government-adjacent actors under the guise of data-driven service delivery and optimization through discourses of leadership, transparency, and digital citizenship. The discourses presented justify the creation of smart policies that rely on increased data collection, reuse, and transparency. Blockchains, agnostic of topology, are perceived by Canadian policymakers as a smart technology that can enhance datafication, provide greater controls over data streams to improve information management, and improve service delivery.

As jurisdictions across Canada continue making blockchain real, geographers might reflect on emerging empirical realities of government blockchain implementations and the policy solutions they offer. Future enquiry could focus on the datafied realities and effects of blockchain services in context-specific geographies, alongside closer readings of blockchain protocols themselves, their stacks, architecture, and use (Rodima-Taylor and Grimes 2019). Forensic analyses of diverse blockchain implementations may reveal corporate logics feeding government blockchain hype, including details surrounding public-private partnerships. Close readings of the government blockchain initiatives may also highlight which bodies can access government blockchain data and to what effects, while studies emphasizing alternative,

bottom-up data epistemologies from the Global South could draw attention to liberatory use cases of the blockchain. Relying on limited implementations of a technology to make sweeping digital changes in governing practices may not be a smart choice. Yet a collective understanding of the material realities of blockchains can help sketch the contours of the “black box” encasing blockchain technology, exposing its limits and potential points of entry.

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Chapter 6

Conclusion

This chapter summarizes the contributions of this dissertation, some of the major limitations impacting the research process and outcomes, and future opportunities to expound upon the ideas and research presented herein. I begin by recounting the underlying arguments of this dissertation before detailing the more prominent conceptual, analytical, methodological, and empirical contributions made in each chapter. Then, I engage with some of the more significant limitations of this research project. I conclude the chapter with a brief overview of future research trajectories related to the findings and outcomes of this dissertation.

Main arguments and contributions

The research presented in this dissertation occurs in the midst of a 'digital turn' in geography and responds to a call by Ash, Kitchin, and Leszczynski (2018, p. 27) to analyze 'how the digital inflects geography's many subfields and mediates how geographical knowledge is produced'. The authors specifically emphasize a need for geographers to interrogate digital materialities using what they call 'innovative' techniques focused on 'substantive empirical examination' (p. 36). This, they argue, promises insights about the diverse ways digital technologies become operationalized and their effects (Ash, Kitchin, and Leszczynski 2018, p. 36).

This dissertation engages with the call above through a critical cartography of blockchains that sketches the micropolitical realities and, indeed, geographies, of these 'disruptive' technologies. The critical cartography presented in this dissertation departs

from the majority of geographical projects invoking the term and is instead inspired by feminist new materialist scholars who conduct cartographies of the body. This critical cartography therefore focuses on sketching a politically informed map of *my* present moment and, to put it in disciplinary terms, an autobiographically-informed map of blockchain geographies. These mapping practices therefore involve figurations of the present, where the present comprises nearly the last seven years or so, and where I report out, predominantly relying on a combination of auto-methods, such as auto-ethnographic and autobiographical strategies, as well as qualitative research techniques, on my participation and observations of blockchains.

Each paper in this dissertation attends to the micropolitical geographies of blockchains in a distinct way. The research presented in Chapter 2 sets up a conceptual scaffolding to frame the approach of my research as one largely driven by an interest in sketching out processes of nomadic subjectification that become possible through the use of blockchains (Sotoudehnia 2021a). Subjectivities become 'mapped' through a variety of economizing practices made possible by blockchains in some way. Chapter 3 uses autobiography as a mode of analysis to detail the spatial micropolitics actualized through my pregnant body while working in Toronto's blockchain industry or crypto-economy (Sotoudehnia 2019). Chapter 4 accounts for the multiple realities of time enacted through blockchain practices, namely the 2016 Ethereum hard fork and DAO hack (Sotoudehnia 2021b). Chapter 5 deals with processes of materialization through a recounting of policy discourses about blockchains that position the technology, loosely defined, as a pathway towards data-driven value generation and smarter governance (Sotoudehnia 2021c).

Contributions by chapter

Chapter 2

In Chapter 2, I argue that blockchains participate in the wider practices of economization, and that the rambunctious quality of that economization produces nomadic subjectivities. Economization is rambunctious because it does not always become capitalist (but it can). Drawing on feminist scholarship in political economy and new materialisms, my primary task in this paper is to add to the literature on blockchains, cryptocurrencies, and digital geographies by thinking through the exuberance or rambunctious characteristic of blockchains in relation to capitalism. My goal, therefore, is not to proclaim some grand theory about what blockchains mean in the context of a monolithic capitalism, but to instead offer a variety of stories that demonstrate how blockchains can be economized, and how that process of economization can or may not align with dominant thinking about digital capitalism. I extend geographical debates about the digital economy by conceptualizing it as diverse, multiplicitous, inchoate, and not necessarily always already capitalistic. This approach, I argue, promotes a minor geography in my analysis to build upon feminist digital geographers interested in “minor gestures” (Leszczynski 2020; Katz 2017; Moss and Falconer Al-Hindi 2008). I also add to longstanding discussions about the relationship between digital media, economies, and processes of nomadic subjectification that do not, by default, produce negative subject locations and identities (Lazzarato 2014; Berardi 2009, 2011). Empirically, Chapter 2 sketches the embodied realities of life with blockchains to highlight the multiplicity of economic rowdiness and power relations in

blockchain systems. The empirical contributions of Chapter 2 add insights into the materialities of life with blockchains.

Chapter 3

Chapter 3 contributes to feminist geographical discussions about embodiment, pregnancy, and subjectification in creative, on-demand economies through autobiographical memories presented about my work at a blockchain start-up in Toronto's crypto-economy. I use autobiography to analyse the power or force relations that flowed through and around my pregnant body during my employment at a blockchain start-up in Toronto, Ontario, and to underscore the agentic characteristics of emotions.

Autobiography, through memory-work and reproduced reflections about my work in the start-up, allows me to carry out an embodied analysis of power as it flows in generative or restrictive ways for researchers navigating the 'field'. Autobiography is a useful analytical tool to recount processes of becoming that may be construed as joyful, and where the actualization of a momentary, joyful subject can involve a variety of positive, ambivalent, and negative experiences. The memories reproduced in this article add to ongoing discussions in geography and cognate disciplines about the contradictory and gendered realities of work in creative, on-demand, digital economy. As cryptocurrency, blockchain, and wider Decentralized Finance (DeFi) become institutionalized sectors of the mainstream 'economy', the findings from Chapter 3 offer insights about gender, pregnancy, and the lived, bodily experiences of work in these new industries. Finally, this article illustrates some of the ways geographers can apply posthuman feminist concepts of power to understand how affirmation materializes in

different bodies through encounters, relationships, and momentary resistances to restrictive power flows. Empirically, this article reveals some of the variable ways pregnant bodies navigated the crypto-economy and therefore builds upon a swath of feminist geographical research about embodiment, pregnancy, and gender in the creative and on-demand economies.

Chapter 4

This article sketches the multiple temporal pulses that can materialize as a result of blockchain events, or specifically hard forks, and their spatial effects. Conceptually, Chapter 4 contributes to recent interventions about the spatialization of time through digital media. The article also contributes to the literature on cryptocurrencies and blockchains by presenting a close analysis of one particular blockchain event: the 2016 Ethereum DAO hack and subsequent hard fork. Chapter 4 depicts some of the lived realities associated with cryptocurrency and blockchain trading, emphasizing blockchains as a technology that produces highly uneven geographies.

Chapter 5

Chapter 5 adds to digital geographical scholarship on datafication and smart discourses by reporting on some of the dominant discourses circulating in Canadian (and other) policy networks about blockchains. Research findings suggest that Canadian policymakers perceive blockchains as value-producing, smart, digital services that can enhance datafication and service delivery by demonstrating a government's digital leadership, transparency, and smart governance.

Blockchains, as they are understood by Canadian policymakers, are being promoted and adopted as a technological panacea that promises to enhance data collection, transparency, and quality. Government blockchain initiatives in Canada and elsewhere demonstrate the logics of fast digital policy that seeks to leverage ‘disruptive’ technologies to enhance the design and delivery of government services. The study, however, reveals that smart discourses about the blockchain are, well, overhyped. A brief forensic survey of blockchain implementations by a variety of governments and government-related entities exposes a number of risks associated with uncritical blockchain adoption. While it is no secret that blockchains are overhyped distributed databases, Chapter 5 grounds such claims with empirical evidence, adding to an emerging pluri-disciplinary literature that interrogates the promises of these ‘disruptive’ technologies.

Methodological contributions

Every paper in this dissertation plays with qualitative and post-qualitative methodologies and aspires to carry out a sort of anti-methodology (Nordstrom 2018). In this way, the methodological contributions of this dissertation are largely experimental and illustrate my own attempt at methodological rebellion (McKittrick 2021). Throughout the research process, I sought to decentre subjects, resist the urge to make meaning, and fall into the trap of perspectivalism (Moi 2002). Despite my intent to do these things, as one reads through the text, it becomes evident that I don’t always fully divest the research of representational pitfalls and interpretation. I still, for instance, rely on conventional interview “data” and, while I tried not to fall prey to ‘mechanistic coding’, I don’t always

succeed (Jackson and Mazzei 2013, p. 261). Chapter 5 is perhaps the most obvious example where I rely on interpretivism to analyse and present results.

Despite the methodological variability evident throughout the dissertation, the research does contribute to current methodological forays in digital geographical scholarship since every paper presents some sort of material and lived reality with and about blockchains. I use auto- and other embodied methods to advance a minor geography, extending feminist work that continues to be marginalized by dominant approaches in human and, more specifically, digital and economic geographies (Moss and Besio 2019). This enables me to implicate myself in the everydayness of blockchains and attend to what Kinsley (2014, p. 378) calls ‘material specificities of the production processes of digital technologies’.

Limitations

This dissertation has no shortage of limitations. I attend to some of the more prominent constraints and shortcomings of this text: scope, format, and methodology.

First, the research presented in this dissertation suffered from scope creep. Writing a proposal that articulated a flexible but defined research plan, process, and analysis in 2014-2015 on a phenomenon that, in its 12 years of existence, has experienced continuous, widespread change while also oscillating between fringe technology and tech bros’ *darling du jour*, was, in retrospect, not the most strategic approach for a doctoral research project. From the launch of Ethereum to the bitcoin scaling debate, institutional obsession to “blockchain all the things”, the DAO hack, the 2017 ICO craze, the emergence of Decentralized Finance DeFi, Dapps, and yield farming, as well as the latest 2020-2021 bullrun, the blockchain has and remains a

volatile and quickly changing topic to research. As bitcoin, cryptocurrencies, and blockchains evolved throughout the research for this dissertation, a number of different threads of enquiry became irrelevant or too difficult to analyse. Since 2013, I have tried to interrogate the blockchain's present moment by attending to its various empirical possibilities. I did this by trying to keep pace with any new developments, making it a challenging and sometimes futile task. Yet as the research process unfolded, I became less interested in diagnosing blockchains and cryptocurrencies or proposing some definitive and stable knowledge about either, and more interested in questions of embodiment and situations where power relations were scary, confusing, contradictory, exciting, weird, wonderful, or unanticipated. This, along with a loss of interest in heterodox political economic literature I used to frame my doctoral research during the early stages of my studies, an emerging (and late) interest in feminist thinking that cut across disciplinary boundaries, and the use of what many geographers might consider "experimental" methods, resulted in continuous adaptation of my research approach, process, thinking, and outcomes.

Second, early on in my doctoral studies I opted for the paper-based option the University of Victoria offers for doctoral dissertations. A paper-based dissertation comprises a collection of papers on a topic of study that are meant to be (or become) stand-alone articles. At the time, I was committed to pursuing an academic career, and the paper-based format appeared to offer a relatively quick dissemination method of peer-reviewed articles over the publication of monographs. Despite warnings about the limitations of the paper-based format from some of my mentors, I perceived it to be the best way I could position myself to be a competitive candidate in an ever dismal

academic job market. I was wrong. The paper-based format doesn't lend itself particularly well to auto-methods and "creative" writing formats and, over time, I learned that shoehorning autobiographical and auto-ethnographic research into a journal article format kind of sucks. As a result, the ideas presented in the dissertation are not always as coherent as I would have liked, and the analysis presented, especially in the published or submitted articles, is often curtailed due to word limits.

Peer-review is an amazing (albeit sometimes flawed) practice, and I have benefited tremendously from constructive, generous, and supportive editors and reviewers throughout my doctoral studies. Yet, the peer-review process can tilt the framing of a text, sometimes impacting the direction of an argument, or even the concepts used to discuss a particular phenomenon. With autobiography, auto-ethnography and wider auto-methods, and especially since these approaches continue to hold marginal or minor positions in geography to this day, the peer-review process resulted in certain concessions I made in Chapters 4 and 5 regarding my discussion of methods, the presentation of empirical findings, and even the types of literature reviewed. Peer review sometimes left me having to retrofit arguments from specific papers into my overall goal and objectives. I sometimes felt as though I was losing the thread or purpose of the dissertation as a whole, leaving me intellectually dispirited and apathetic towards the research project.

Another limitation of the paper-based thesis option is that the cumulative text involves a lot of repetition. In this context of this research project, the mere complexity and rampant obscurantism of the topic in question means that each article has a slightly

different version of a blockchain explainer, resulting in a monotonous and rather tedious reading experience.

Third, my original avowal to interpretivist methodologies and subsequent attempt to develop a sort of anti-methodology, posed a severe constraint that I never fully resolved. When I began collecting data for this project, I did so with the intent to primarily rely on semi-structured interviews, digital ethnographic methods, and participant observation. My quick transition from outsider to insider in Toronto and subsequently Victoria's crypto and blockchain communities, along with the wild valuation swings, investment interest in blockchain projects and cryptocurrencies, and social realities of some of the people who cling to these communities made interviews increasingly unpalatable to conduct, in some cases unsafe, or moot. In 2015-2017, many interviews, for instance, betrayed ulterior motives (e.g., participants agreeing to an interview only to spend the entire time trying to sell me some shitcoin, get me to advise, invest, or work for a startup, or to try to get a date), and by 2017 I had developed a sort of pervading mistrust and disdain for many of the folks I encountered in person or online. This, and my rising interest in auto-methods, post-qualitative, non-perspectival, and anti-interpretative methods (Jackson and Mazzei 2013; Mol 2002; Nordstrom 2018), led me to favour auto-ethnography and autobiographical reflections, excerpts from my field journals, and various other forms of memory-work over more conventional qualitative data and analysis techniques I initially set out to use for data collection, coding, and analysis. As a result, my practice of an anti-methodology oscillates, and I sometimes slip back into more humanist methodologies.

Future research

The ideas detailed in this dissertation leave much analytical, conceptual, empirical, and methodological terrain under or unexplored. What I've presented throughout the text are a collection of concepts "plugged into" different empirical and embodied events, encounters, and memories about blockchains (Jackson and Mazzei 2013, p. 262). There are a multitude of ways researchers could take up any one of the concepts, events, or statements presented about blockchains and synthesize different research questions. Indeed, many scholars are. At the time of writing, pluri-disciplinary scholarship on blockchains is reaching a point of saturation. A quick search on the Web of Science, for instance, displays the total count (10,695) of peer-reviewed articles (including early access articles) with the keyword "blockchain" published from January 2013 to April 2021 (Web of Science 2021). This figure highlights the rising popularity of blockchain as a research topic since 2013 (Web of Science 2021). Notably, however, of the 10,000 plus articles on the topic, geographical research on the "blockchain" only accounts for 0.15% or 16 articles on the topic (Web of Science 2021). This trend indicates that, while blockchains research is now commonplace across a variety of disciplines, formal geographical research on the topic remains nascent.

The relative dearth of geographical scholarship on blockchains demonstrates a need for additional analysis. The papers above engage with partial aspects of blockchain geographies, but future work could engage more systematically with the materializing and spatializing processes involved with the promotion, design, and implementation of various public and private blockchain protocols. This thread of enquiry may be particularly topical given the persisting interest by institutions and governments to experiment with these technologies. A closer emphasis on the

spatialization of blockchain deployment would also provide overdue insights into the constraints and politics associated with a category of digital media that is technically complex to implement and relies on mostly obfuscatory discourses. The opacity of what a blockchain is has significant implications for future geographical work on datafication, especially for scholars interested in posthuman and new materialist perspectives. As personal datafication methods become more sophisticated, geographers may seek to inquire into the variety of formats that datafication can take and interrogate how these data are collected and expressed on blockchains (Lupton 2019).

Blockchain implementations will continue to mature and become standardized, leaving ample analytical room to investigate the ethics, materialization, politics, and political economies of blockchain standardization endeavours. Geographers could, for instance, draw on nondualistic readings of digital spaces to extend the discussions from Chapter 5 and interrogate what it means to “make the blockchain real” (Massumi 1987). Future research could draw out explicit connections to the various ways that blockchains make spaces “more-than-real”, with an emphasis on the concretization of different blockchains that are either at the development stage, in production, or abandoned (McLean 2020). As McLean (2020, p. 3) explains, ‘the more-than-real sits with ideas about how digital ideas are made and are making us’.

While there is current work underway (elsewhere) to examine cryptocurrency mining, this remains a research trajectory that would merit closer and more sustained geographical analysis. Mining practices involve a variety of geographical considerations including but not limited to energy consumption, resource extraction, regulatory arbitrage, and decentralization.

A concerted and larger scoped examination of blockchain materialities would also generate conceptual and analytical linkages between some of the same questions broached above and how blockchains, through their supposed decentralization, extend or resist capitalism in material ways. As decentralized finance (DeFi) gains popularity, geographers are well positioned and suited to interrogating the logics of these unregulated financial activities and how they become economic.

Additional geographical analysis of blockchain events, especially in the context of cryptocurrencies, promises to reveal wider insights into the materialities of time. Specific focus on the instability, logistics, and subjectivity of time, for instance, in blockchain industries, in their design and implementation, and usability could provide much needed context about the ways digital technologies such as blockchains organize daily life (Lammes et al. 2018).

Blockchains remain a popular topic of discussion within and beyond the academe. Academic and media coverage about blockchains continues to place significant emphasis on demystifying or theorizing the technology (Kimani et al. 2020). Meanwhile, a swath of critical research within and beyond geography aspires to move beyond grand, universalizing narratives about newfangled digital technologies to instead focus on what these technologies do when they are used. This dissertation is inspired by the latter approach to sketch a context-specific map of blockchain practices I undertook or witnessed since beginning this research project in 2013. My approach, which I earlier describe as a critical cartography, seeks to locate situations of power, their resulting subjectivities, and the spatial, temporal, and material realities of these lived subjectivities. In this way, the research presented throughout this dissertation

contributes to feminist digital interventions in geography that eschew conventional top-down, oppositional, and dialectical theorizations about platforms and their related digital objects to begin instead from the ‘empirical ... specificities’ of blockchains to map out their ‘everyday contingencies’ and their various ‘comings-together’ (Leszczynski 2020, p. 14). This, as Leszczynski (2020, p.15) explains, allows for a greater diversity and indeterminacy of imagination that may inspire geographers to dream up more generative digital futures. While the research in this dissertation attempts to understand the lived geographies of blockchains, it does not proffer specific or in depth blockchain imaginaries enacted through some of the blockchain’s more generative realities. There remains ample room for contributions on this research front, and future empirical research about blockchains could account and investigate more hopeful blockchain realities, where protocols, implementations, and encounters with the technology offer corrective counterpoints to dominant theorizations that represent the blockchain as the always-already ‘enfant terrible of the global economy’ (Zook and Blankenship 2018, p. 248).

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