Appendix 1: A Brief History of Monetary Control

According to archeology, forms of debt management and reciprocation predate currency exchange in local communities throughout history (Graeber, 2011). The earliest records of financial technology dates back to 3100 BC in Uruk, Mesopotamia, where royal palaces and temples used stone tablets as accountancy ledgers for marking deposits of commodities such as grain (Oates, 1986).[1] Various apparatuses like this have been used in different cultures to organise economic transactions (Davies, 1994; Weatherford, 1997). Alongside such inscriptions, used for settling ownership, emerged different tokens utilised as forms of money—like precious metals that were later tied to nation state sovereignty through coinage. To maintain trust in these material-economic systems, and thus allow token value to carry into the future as socialised forms of reciprocation, they often demanded some form of 'overseer.' Of course, supervisors can act corruptly, which gave rise to a philosophical question concerning centralised tyranny, originally posed by the Roman poet Juvenal: "who will guard the guards themselves?"—a problem blockchains look to solve.

The first commercial banks emerged in Renaissance Italy with the invention of an innovative financial instrument: the banknote. It was a tool used by pioneering goldsmiths: what "started out simply as paper records of credit transactions and transfer payments gradually became transformed into a significant extension of the metallic money supply" (Davies, 1994, 251). This would eventually have extreme impacts on the economy as the "invention of banking and the paper money system destroyed feudalism, changed the basis of organization from heredity to money, and it changed the basis of economic power from owning land to owning stocks, bonds, and corporations" (Weatherford, 1997, xii–xiii).[2] This demonstrates how material networks of money are deeply connected to the spatialisation of economies. Bills of exchange freed the value of

money from the confines of precious metal coinage, which could be deposited at the bank (for a fee) while their value was readily exchangeable with issued paper credits (Weatherford, 1997, xii–xiii). Banknotes were effectively as 'good as gold' and remained so until privatised institutions discovered the art of money creation through a paper-based form of debasement that pushed money "beyond the limits of minting" (Davies, 1994, 149). By issuing more banknotes than they had gold in reserves, banks had produced an early form of fractional reserve banking: in effect, creating money from nothing.

Money creation "provoked a boom in the European markets by helping to overcome the vastly insufficient supplies of gold and silver coins. By making the system work much faster and more efficiently, they increased the amount of money in circulation" (Weatherford, 1997, 77). Yet, with it came a systemic obligation for depositors to trust their banks not to inflate the money supply. In this kind of system, monetary policy can be seen as 'decentralised' as no single entity has a monopoly on the creation or regulation of currency—although individual deposit control remained centralised because institutions are trusted to hold money. In a sense, this 'free banking' model self-regulates itself through reputation-based self-preservation in a competitive market that reduces moral hazard for individual banks who are only as strong as the overall whole and therefore each other (Bagehot, 1873).

The Scottish model of free banking between 1716 and 1845 is often given as evidence for its potentially positive competitiveness and stability (White, 1992; Kroszner, 1995). Naturally, then, free banking adheres to a trust in market forces to create a functioning financial system with no outside interference or regulation; it similarly represents an inherent distrust in the ability of government bodies to make decisions for the good of the economy (Goodhart, 1991). Free banking resonates with the Bitcoin movement somewhat in terms of a rejection of overarching authorities who some see as guilty of defrauding or plundering the people (Hayek, 1937; 1976). Advocates further argue that authoritative regulation is too conservative or restrictive on competition and innovation in financial markets (Smith, 1936). This cohort sees merit in certain elements of free banking and includes Vera Smith (1936), Friedrich Hayek (1976), Walter Bagehot (1873), David Friedman (1982), Arthur Rolnick and Warren Weber (1983; 1984; 1988), Lawrence White (1984; 1992), Steven Horwitz (1992), and Richard Timberlake (1978; see also Dowd and Timberlake, 1998).[3]

On the other hand, it is argued the absence of a centralised governing body in a laissez-faire free banking system invokes instability (Thornton, 1802); if faith in a bank dwindles, too many withdrawals could soak up its liquidity and the paper money it printed 'out of thin air' would suddenly be worthless. Here, trust in currency reflects trust in commercial banks. Numerous bank runs occurred in the United States during the early 19th century where various forms of free banking were in operation (Gorton, 1985; Markham, 2002).[4] Lack of capital

or fraudulent procedures led to distrust in, and failure of, certain banks; this, in turn, caused contagious panic across the industry (Gorton, 1985; Markham, 2002).[5] It would later become the role of the central bank, or the banker's bank, to undo the risks associated with (more) decentralised free banking systems through the introduction of government monitoring and control via overarching, centralised monetary policy.

The first central banks, however, were private commercial banks not regulators. The Bank of England, for example, was formed by an Act of Parliament in 1694 to raise £1,200,000 from wealthy Englishmen (who would become private shareholders of the bank) to finance the Nine Years' War with France fought by King William III (Andreadēs, 1966: Bank of England, 1970; Bagehot, 1873; Goodman, 2009). This organisation would develop and adopt the modern functions of central banking slowly (Capie et al., 1994). As Charles Goodhart (1991) puts it: "Central Banks have evolved naturally over time" (vii–viii).

The Bank of England originally operated as a "private joint-stock commercial organisation, trading and seeking profit on its own capital resources" (Elgie & Thompson, 1998, 36). While depending on the Bank of England as a "money-raising machine," ministers used the renewal of the Bank's charter as a "bargaining counter" to establish some control over its operations and "keep at least a minimal grip on the terms of credit which they received" (Elgie & Thompson, 1998, 36). In the two centuries following 1694, as the Bank of England "developed the modern techniques of central banking, it continued, under certain formal and informal constraints imposed by different governments, to exhibit substantial levels of economic and political independence" (Elgie & Thompson, 1998, 35).

In 1847, as the Bank was looked to increasingly as a public authority, government passed the Bank Charter Act, restricting the authorisation of new banknotes to the Bank of England and leading to its monopolistic control over the British money supply (Capie et al., 1994).[6] It had, through legislation, become an obligatory passage point for the issuance of banknotes (see Chapter 2). The Bank of England's "privileged legal position, as banker to the government and in note issue, then brought about consequently, and, naturally, a degree of centralization of reserves within the banking system in the Central Bank, so it became a bankers' bank" (Goodhart, 1991, 5). Holding the bulk of the nation's metallic reserve (from the government, commercial banks, and other depositors) gave the central bank a certain degree of power and responsibility. The country would become dependable on it for providing extra liquidity in times of economic difficulty (Goodhart, 1991, 5). Still a private institution, albeit with tight formal (and informal) ties with government, the Bank first acted as the lender of last resort during the widespread panic caused by the credit crunch of 1866 (Fischer, 1999; Flandreau & Ugolini, 2011). This was something that, despite

being wary of centralised control, economist Walter Bagehot (1873) advocated strongly and the Bank of England would later adopt this role as one of its core functions (Goodfriend & King, 1988; Goodhart, 2011). Gradually, the Bank became a "noncompetitive, non-profit-maximizing body" until it was officially nationalised in 1946 (Goodhart, 1991, 45).

Ever since 1914, with the massive amounts of expenditure needed to finance the First World War, ministers had slowly begun to exercise more control over the Bank of England to direct monetary policy towards their own economic visions (Elgie & Thompson, 1998). After it was nationalised, the Bank of England continued to be marginalised in both decision-making and administrative controls, being positioned in more of an advisory role to government who brandished a new hands-on Keynesian economic philosophy of cheap money (Fforde, 1992): expanding currency supply with low interest rates to stimulate lending, employment, and economic growth (Keynes, 1936). In doing so, politicians backed themselves into a corner. With increased inflation and unemployment, the nation's economic state became increasingly a government product and therefore problem. By the 1980s the central bank was truly an instrument of parliament and politicians were feared as an inflation-creating machine (Elgie & Thompson, 1998). Monetary policy became a tool for influencing short-term electoral decisions at the expense of long-term economic stability and so "debate about the value of central bank independence gathered momentum" (Elgie & Thompson, 1998, 66). During the 1990s the Bank of England slowly clawed back greater responsibility and autonomy from the government until Prime Minister Gordon Brown gave it operational independence in 1997. Today, the UK government sets the inflation target for the Bank of England to reach with its own monetary policy.

Many countries have modelled their central banks on the Bank of England yet all have evolved in unique circumstances. The United States Federal Reserve, for example, was formed in 1913 as a direct response to calls for central governmental control of the monetary system to quench the flames of reoccurring financial crises (Warburg, 1930; Hetzel, 2008). President Woodrow Wilson offered the solution of "a public-private partnership with semiautonomous, privately funded reserve banks supervised by a public board. The directors of the twelve reserve banks, representing commercial, agricultural, industrial, and financial interests within each region, controlled each bank's portfolio" (Meltzer, 2003, 3).

Ultimately, a "central bank's authority and scope of action depends on the government" who grants laws giving them degrees of autonomy for pursuing price stability (Cukierman et al., 1992, 354). Naturally, different central banks enjoy varying degrees of independence (Parkin, 1978, 1987; Banaian et al., 1983; Cukierman et al., 1992; Burdekin et al., 1992).[7] The typical paradoxical, or

schizophrenic, situation of central banks—an independent institution directed by government (Meltzer, 2003)—has evolved over time to reflect both private and public interests. Indeed, with private-public components, central banks necessarily adopt a unique structural situation in an attempt to decrease any single body profiting from interference and to increase national economic efficiency (Johnson et al., 1998). However, many commentators of the 2008 global financial crisis, including the early builders of Bitcoin, see the private-public ties of central banks, and their consequential influence, as a dangerous centre of control with its own points of corruption (i.e., bailing out private banks).

Appendix 2: The West African Cowrie Shell

I cannot walk into my local café today and purchase a coffee with a handful of cowrie shells. However, this was a common medium of low-cost exchange in West Africa for centuries (Johnson, 1970; Gregory, 1996; Werthmann, 2003). The discrepancy between different currencies is emblematic of money being constituted and constrained by specific but repeatable cultural-economic practices in space-time. This is further personified by the struggle French colonialists experienced from 1897 when imposing their imperial franc over the cowrie shell economies of Burkina Faso (then Upper Volta) over four decades (Şaul, 2004).

For a time, both currencies operated relatively independently, although with degrees of overlay and friction. Despite the introduction of the franc, the cowrie shell stuck thanks to the cultural potency it carried with the indigenous population: attached to practices of religion, protection, medicine, ritual payment, fertility, divination, and burials (Şaul, 2004). Embedded networks of practice guided by native leaders helped maintain the cultural-economic value of the cowrie shell, sometimes as a direct form of resistance to colonial sovereignty (Şaul, 2004). However, they were eventually disrupted through the calculative methods of French settlers (Şaul, 2004). This included banning imports of cowries, demanding them as tax payments in an endeavour to exhaust supplies, and through confiscation and destruction when authorities seized and burnt shells under the cover of darkness (Şaul, 2004).

Greater acceptance of the franc over cowries occurred with the changing of cultural practice over time. After 40 years of struggle, subsequent generations of the indigenous population, who had grown up under colonial rule, no longer saw the cowrie shell as important to everyday life as their ancestors had done (Şaul, 2004). In other words, the cultural-economic networks of practice in Burkina Faso had changed and the cowrie shell was slowly excluded as a thing-of-economic-value until it was (mostly) eradicated from monetary circulation. This case study captures the social relations intertwined with money as well as

the power that can emerge from its control (Simmel, 1900; Baker & Jimerson, 1992; Zelizer, 1997; Maurer, 2006; Dodd, 2014). At the same time, the specific networks of practice through which money is performed are illuminated as crucial to its existence and maintenance. If these are broken down, they no longer suspend a particular thing into a monetary form (see also Appendix 3).

Appendix 3: The (Swiss-Printed) Iraqi Dinar

A case study that epitomises the suspension of things-as-money via cultural-economic practice is that of the 'Swiss-printed' Iraqi dinar. Following the 1990–1991 Gulf War, Iraq was effectively divided into two areas that were "politically, militarily and economically separate from each other": southern Iraq fell under the control of Saddam Hussein and northern Iraq became "a *de facto* Kurdish protectorate" known as Iraqi Kurdistan (King, 2004, 7). As a result of embargoes under Hussein's rule, the Central Bank of Iraq (CBI) began printing large amounts of low-quality Iraqi dinars using Chinese-manufactured plates depicting Hussein's image. The currency subsequently underwent a period of hyperinflation: the circulation of new notes "jumped from 22 billion dinars at the end of 1991 to 584 billion only four years later" (King, 2004, 7).

Formerly, Iraqi dinars had been printed in the UK by the British banknote manufacturer De La Rue using plates engraved in Switzerland (Koning, 2013). When the new government-backed 'Saddam dinars' were introduced, Hussein revoked the legitimacy of 'Swiss dinars' and offered a six-day period from the 5th May 1993 where citizens could exchange them, after which the CBI would cease to honour their liability (Koning, 2013). Over the same six days, Hussein closed the border between northern and southern Iraq, cutting the northern population off from repatriating their currency (Coats, 2005). This left a large proportion of Swiss dinars stranded in Iraqi Kurdistan (Koning, 2013), backed by "no formal government, central bank, nor any law of legal tender" (King, 2004, 13). The "Kurdish governorates did not have access to the printing plates for the Swiss dinars . . . [and refused] to print low-quality notes of their own" (Foote et al., 2004, 19). This left the population with supposedly 'worthless' pieces of paper backed by no institution at all. Yet, from such an insidious and isolating incision, came a compelling and emancipatory tale of the power of money that demonstrates the necessary cultural-economic networks required for its performativity.

Despite being cut off from any associated government, the population of Iraqi Kurdistan, with little other option, continued to practise economic exchange with the limited supply of Swiss dinars available to them. Rather amazingly, the unsanctioned, illegitimate, and disendorsed banknotes maintained their

economic value over a ten-year period as they continued to be used as money. In a twist of fate, the heavily printed Saddam dinars, which bore the full weight of government backing, devalued tremendously over the same amount of time so that one Swiss dinar eventually had an exchange rate of three hundred Saddam dinars. With "regard to viability, the episode shows that 'intrinsically useless' notes can continue to function as money, even though their use as such is, not only officially unrecognized, but officially condemned" (Selgin, 2015, 96). To add further intrigue to this story, as the invasion of Iraq by coalition forces became ever more likely until its commencement in 2003, the Swiss dinar rose in value relative to the US dollar (Varian, 2004). Financial derivatives played a significant role in this elevation: for example, a particular futures contract "paid out 100 cents if Saddam was deposed by the end of June 2003 and nothing otherwise" (King, 2004, 9). This outside force meant the Swiss dinar became more valuable the more likely the currency would be valued by a subsequent government following a takeover (Varian, 2004).

On one hand, this case study points to the irrelevance of government backing when cultural-economic networks exist to suspend money into a state of agreed-upon value (consensus). On the other hand, it proves expected future value, based on the actions of nation-states, plays a very real role in the forming or dismantling of monetary value. What is consistent here is the necessary trust, belief, or faith present in the humanised geographic spaces that perform money: shifting networks and the withdrawal or introduction of new actors maintained and changed the value of the Iraqi Swiss-printed dinar. In other words, money maintained its value thanks to a 'suspension of disbelief.' When relationships change, so does the value of money they suspend.

Appendix 4: Monopoly Money

The phrase "Monopoly money" references banknotes used in a common board game and is sometimes used in popular culture to describe currencies treated as worthless (Boise, 2005). However, within the 'networked economy' of the Monopoly board these notes are imbued with a particular potency. Interior to the game, this currency can be used to buy plastic hotels or pay rent to another player: it is a powerful medium within its context and, indeed, the game could not function without it. As the 'banknotes' are passed around they become a form of money inside the small spatial-temporal network created around the board. The performance of this network is exemplified (and destroyed) when a cheater enters the game's economic system: if someone steals extra notes from the bank and others notice, then trust in the currency breaks down. Suddenly, the performativity of money is broken and the notes become worthless bits of

paper (again) that can no longer be used to make purchases or payments. While fiat currency and other monies may be more complex and spatially far-reaching, the networked practices by which monetary value is suspended acts in a very similar way.

Appendix 5: Imperfect Monies

In 2017, the inflation rate of the Great British Pound was at 2.9% (BBC, 2017). To put it crudely, this means that GBP loses 1.1% of its value annually, represented by the rise in prices of goods and services.[8] A small amount of inflation in capitalist economies is widely regarded as a positive attribute because it stops money being hoarded as a *store of value* and encourages it being spent as a *medium of exchange*, which, in turn, boosts economic growth. While the British pound continues to be used as a *unit of account*, its buying power decreases when more money is injected into the nation's economy. This reinforces arguments that state the functional triad of money is unstable (see Chapter 2).

When merchants (such as Microsoft, Expedia, Gyft, and Overstock.com) accept bitcoins as a means of payment, the value of goods is pegged to fiat money. Yet the same can be said for the inflationary Argentinian peso. Legally, citizens must pay with 'state-printed' currency but, because the Central Bank of the Argentine Republic has broken fiduciary trust with its citizens (and 'globalised' currency markets) by printing more and more pesos to pay for the country's debts, its value has constantly fallen.[9] Consequently, Argentinians usually store their wealth with US dollars, giving rise to the occupation of currency traders who swap US dollars (as a *store of value*) for pesos (as a *medium of exchange*) at the time of purchase—interestingly, the Argentinian peso was for many years statutorily pegged 1-1 to the US dollar. Despite its current inability to act as a steady *store of value* and thus decent *unit of account*, economists still call it money—merely referring to it as a 'failing' or 'poor' example.

Hyperinflation is the name given to the phenomenon when monetary value drops at an extortionate rate. This occurred in post–World War I Germany as the government printed vast amounts of German marks to pay for the country's war debt: by 1923 the US dollar was the equivalent to 4,210,500,000,000 marks (Pollard & Holmes, 1973; Widdig, 2001). Historical photographs depict Germans collecting wages with wheelbarrows, children playing with bundles of banknotes as substitutes for building blocks, and people using marks as wallpaper or kindling—an example where a money's 'material use value' as paper overrides its value as a store of wealth. More recently, the hyperinflationary Zimbabwean dollar soared to an inflation rate of up to 79.6 billion per cent in 2008 (Hanke & Kwok, 2009). This downward spiral of value was personified by

an (in)famous photograph of a Zimbabwean citizen holding a cardboard sign that read "Starving Billionaire." The Central Bank of Zimbabwe ended up issuing individual banknotes for one hundred trillion dollars each. These case studies describe situations where the functions and, by proxy, definitions of money become difficult to discern, at the same time as alluding to its varying contextualisations across different space-times.

Cumbersome examples and definitions of money suggest that refusing to consider Bitcoin within monetary scholarship, due to its own awkwardness, would be an early and narrow-minded judgement call to make. I certainly take critiques on board but also argue that Bitcoin's "moneyness" should not be immediately dismissed (Ingham, 2004, 9). After all, definitions of money have evolved with its (im)material transformations through time (Quiggin, 1949; Davies, 1994; Weatherford, 1997; Zelizer, 1997; Leyshon & Thrift, 1997). Some cases have been a result of gradations in cultural practice whereas others, such as the colonial imposition of the franc in West Africa (see Appendix 2), have, understandably, been nothing short of culture shocks (Johnson, 1970; Gregory, 1996; Werthmann, 2003; Şaul, 2004). At this time, with such a rapid and dynamic shifting of currencies and payment technologies (Castronova, 2014; Lovink et al., 2015; Maurer & Swartz, 2015; Maurer, 2017), it seems most appropriate to encompass such developments into monetary theory and bring them into conversation with pre-existing definitions of money.

With this in mind, I treat Bitcoin first and foremost as a cryptocurrency. In other words, instead of attempting to label Bitcoin with pre-definitions, I treat it as a newfangled entity that sometimes acts like money and at other times like a speculative asset, stock, payment network, or digital gold (of course, other monies can act like some of these things as well). To use an analogy, in science under some empirical tests light acts like a wave and in others like a particle. I find this a useful parallel for Bitcoin because it acts like many other 'things' depending on the angle it is observed from. Consequently, it is conceptually advantageous to treat Bitcoin as something new entirely, possessing qualities of the different 'assets' outlined above—which can often be seen as monetary extensions themselves (Leyshon & Thrift, 1997). In short, I look at how Bitcoin and blockchain technology connect people and value through the spatial and cultural practices that form them.

Appendix 6: A Constantly Evolving Space-Time

Modern societies are defined by complex mobilities (Urry, 2007). The borders of countries, regions, and states, for example, are not stationary but shifting, semi-permeable, and dynamic, with countless flows of people, commodities, and ideas

traversing (or inducing) their spaces (Massey, 1991; Macleod & Jones, 2001; Terlouw, 2001; Mezzadra & Neilson, 2013). Cities are not stable in and of themselves but are continually *made* through an array of complementary and competing processes (Hermant & Latour, 1998; McNeill, 2017). Similarly, everyday things are far from motionless. Taking the obelisk known as Cleopatra's Needle in London as an example, it is part of a "continual differing" (Anderson & Harrison, 2010, 20): "a physicist who looks on part of the life of nature as a dance of electrons, will tell you daily it has lost some molecules and gained others" (Whitehead, 1920, 167). Meanwhile, the earth is spinning rapidly on its axis, swinging around the sun, and being flung outwardly through the galaxy at 1,300,000 miles per hour. With this in mind, there is obviously nothing static about dimensional space. Instead, it is always relational to varying tempos of movement: a glass sitting on my table is not still by any means, only relative to other things like the table, the room, or the earth. Even the stillest environments emit a "background 'hum' of ongoing activity" (Anderson & Harrison, 2010, 6). Things often considered fixed are in a persistent state of change: co-contributors to a perpetual dynamism, patrons of space and time. To think about geographies, then, is to understand a constantly busy vortex of trajectories, alive with movement (Massey, 2005).

Appendix 7: Actor-Networks

Works that utilise actor-network theory recognise the multiplicity and complexity of life and acknowledge a lack of unified narrative for anything (Mol, 2002). There are, then, many Bitcoins at work at any given time.[10] My research explicitly seeks to illuminate parts of this multifariousness:

> [A]ctor-network theory is descriptive rather than foundational in explanatory terms. . . . Instead it tells stories about 'how' relations assemble or don't. As a form, one of several, of material semiotics, it is better understood as a toolkit for telling interesting stories about, and interfering in, those relations. More profoundly, it is a sensibility to the messy practices of relationality and materiality of the world. Along with this sensibility comes a wariness of the large-scale claims common in social theory: these usually seem too simple. (Law, 2007, 2)

A key objective here is to dissolve traditional Cartesian dualisms and unlock "more-than-human geographies" (Whatmore, 2006, 604). This hybrid approach opens up "analytical space for nonhuman agency as an emergent relational property" (Lorimer, 2007, 913). In the case of this book, it explains how objects and (infra)structures take shape through networks of practice and provides a framework for understanding the material messiness of algorithmic architectures that

are 'assembled' via a myriad of processes. This acknowledges the "living fabrics" of social life: "relational configurations spun between the capacities and effects of organic beings, technological devices and discursive codes" (Whatmore, 2000, 266). After all, the "mixtures and configurations of machines, animals, states, organisations, ecologies, [and] politics are continually made up of all manner of elements, which themselves are nothing if not hybrid forms" (Hinchliffe, 2007, 51).

Appendix 8: The Demonetisation of India

The vulnerability of citizens to centralised institutions was personified in India at 8.00pm on the 8th November 2016 when the country's prime minister, Narendra Modi, suddenly announced the demonetisation of all 500 and 1,000 rupee banknote denominations, with the aim of reducing counterfeiting, discouraging tax avoidance, and curtailing the operations of black markets. At midnight that same day, the invalid notes would no longer be accepted nationwide but citizens had until the 26th December to exchange them (with an initial limit of 4,500 rupees). Subsequently, citizens queued at banks all over the country in order to redeem expiring banknotes for government-sanctioned money. This had a significant effect on rural areas where people had to travel to the nearest town to exchange their currency (Doshi & Allen, 2016). A number of deaths were linked with the crowds that gathered outside banks (Dhupkar, 2016), as well as the non-acceptance of demonetised denominations at hospitals (Rajeevan & Ganapatye, 2016).

The withdrawal of 500 and 1,000 rupee banknotes, accounting for 86% of India's cash by value (Manish, 2016), also had a staggering effect on the nation's economy (Reddy, 2017). Poorer citizens were accustomed to using the revoked notes as a store of wealth and, with no record validating their income source, they were unable to exchange them for legitimate currency. Instead, the largely illiterate populations living in rural villages had no other choice but to open bank accounts with no prior knowledge of the associated procedures nor the money to bear the costs of maintaining one. Demonetisation had forced the poorer populations to embrace more modern forms of financial exchange and divorce traditional means but at severe economic costs. Former Indian prime minister Manmohan Singh called it "organised loot and legalised plunder" (Quartz India, 2016).

Appendix 9: State-Controlled Inflation

The majority of central banks are afforded the power to make alterations to monetary policy. Money, under state rule, is currently created as debt through loans (Graf, 2013); central banks determine the volume of 'base money'—a pool

commercial banks borrow from. By adjusting the interest rates of these loans and by changing the minimum deposit commercial banks must keep with them, central banks maintain control over the total money supply. They manage and alter systematic components by tweaking the key lending rate. If central banks lend money to commercial banks with low interest and lower the minimum deposit requirement, then banks like Barclays or Wells Fargo can lend 'cheap money' to the public less expensively. This has the overall effect of increasing the total money in circulation.

If monetary supply increases without national economic growth, then inflation sets in: because there is more money available, each unit of currency becomes less valuable and its buying power is reduced. This is reflected in the rising price of goods and services (hyperinflation is this process on steroids—see Appendix 5). Effectively, printing more money saps value from public deposits. To counter this, the central banks can raise the key lending rate and raise the minimum deposit requirement to decrease the money supply. In the case of the Eurozone, nation-state central banks must also keep their own deposits with the European Central Bank who ultimately alter the interest rates for the entire euro.

Appendix 10: Losing My Religion

When I first 'went down the Bitcoin rabbit hole' I was utterly engrossed by the compelling and pioneering visionaries working on the political fringes to neutralise monetary control. Fascinated by Bitcoin's unique mode of value formation and the plethora of social practices blockchains promised to decentralise, I quickly became a proponent. My enthusiasm was heightened upon entering Silicon Valley in 2015 where I felt like I was at the forefront of something world-changing and emancipating: the next 'technological revolution' (see Chapter 7).

'Going native' is a term suffering from anthropology's colonial history: it was originally used to depict European anthropologists getting too close to the 'otherly subjects' they were researching in 'distant lands,' thus losing critical detachment. This term carries historical and political weight, which is in danger of reinforcing fallacious binaries between stranger and native, white and black, West and East, culture and nature (Said, 1978). Instead, I use the term 'cultural absorption' here to describe the difficulty ethnographers experience when researching any group of people they could try to understand.

Despite my best efforts, the Bitcoin community absorbed me as a participant observer working for cryptocurrency companies, attending meet-ups, and interviewing people with gregarious personalities. Carrying an optimism for

algorithmic decentralisation, I adopted part of the mindset previously described as the Californian Ideology (Barbrook & Cameron, 1996). I first read the article where this term is devised before conducting field research, taking it with a pinch of salt and brushing it off as a poetic exaggeration of high technology culture, with loose analytical comparisons to Jeffersonian democracy and the West Coast expansion of the United States. It was only when I returned to Sydney to analyse my data, I started to realise how much I had adhered to this mindset along with its philosophical contradictions. This is something also recognised by Nigel Dodd (2017) in terms of Bitcoin proponents:

> When I asked a Bitcoin trader about the theory of money underlying his understanding of cryptocurrency, he compared Bitcoin to gold; indeed he suggested that the currency was superior to gold because its supply could be absolutely fixed (at 21 million coins) by the underlying software. At the same time, he conceded that it is possible for the chief scientist at Bitcoin to remove the cap on Bitcoin production, for example by doubling the total number of Bitcoins that will eventually be mined to 42 million. . . . [S]uch a move would undermine the techno-utopian ideals that are so important to Bitcoin, which hinge on the argument that the supply of Bitcoin can never be altered. When I put this point to the trader in a question, he suggested that the belief that the total number of Bitcoins would never exceed 21 million acts like a socially necessary fiction that holds the network together. In other words, while the chief scientist at Bitcoin could indeed raise the cap, he was highly unlikely to do so because such an action would shatter the belief-system that sustains the network itself. In other words, the trader I was speaking to appears to behave like a gold bug, while thinking like a social constructionist. He saw no contradiction in his position. (8–9)[11]

Echoing these paradoxes of thought, I would often assert how Bitcoin was completely distributed, while willingly ignoring the holes in this argument even though I knew they existed, probably because they disrupted an exciting but fantastical imaginary of a distributed world on the horizon, just out of reach. With this form of confirmation bias, I was fulfilling my own role as a Californian Ideologue. From subsequent analysis, where I continued to develop a relational and spatial lens through which to understand (de)centralisation, different and uneven patterns of power became increasingly evident. I was thus forced to shed the worldview I had partially adopted during fieldwork.

Appendix 11: Debunking Commodity Fetishism

There is a tendency to focus on the materiality of commodities like iPhones and iPads (as if they appear out of thin air) while remaining oblivious to the many hidden people that bring them into being—and sometimes suffered in the process. There are many ways in which this spell can be broken. For example: consumers finding photos on their iPhones of posing Chinese factory workers who once assembled them (Cook, 2011); 'culture jamming' by activist groups like the Yes Men who once created a fake website depicting iPhones made from "conflict free" materials (Parkin, 2011); news articles on the suicides of Foxconn assembly line employees who make components for iPads (Hickman, 2010), or; documentary films revealing the war, genocide, and child labour associated with Congolese mines that extract cobalt—a mineral essential for manufacturing electronic goods (Forestrier, 2007).

Appendix 12: Screen Essentialism and High Frequency Trading

Software now saturates daily practice to the extent it has become part of the "epistemic wallpaper" of everyday life (Thrift, 2004, 585): while assiduously active, it blends into the background noise of the normal and mundane. Digital data appears to float around as a metaphysical phenomenon—especially since the rise of the Internet and cloud computing, both of which conjure up an imagined space sequestered from the corporeal. Here, software becomes a "visibly invisible" essence (Chun, 2008), with the "visible code written by the programmer . . . made invisible at the moment the code is compiled" (Galloway, 2004, 65).

Algorithms, composed of the commands facilitated by computer code, are largely ignored despite their inextricability to the hyperconnected data-driven global economy (Kemp-Robertson, 2013):

> Once we become habituated to infrastructures, we are likely to take them for granted. They become transparent, as it were. But there is something distinctive about the invisibility of algorithms. To an unprecedented degree, they are embedded in the world we inhabit. This has to do with their liminal, elusive materiality. In sociological parlance, we could say that algorithms are easily black-boxed. (Mazzotti, 2017)

Disregarding code and the material infrastructure that supports it, however, can have profound implications. This was exemplified by the exposure of Wall Street

to High Frequency Trading (HFT), a practice that secretly and parasitically attached itself to the world economy in the form of algorithms purchasing stocks from electronic exchanges. Since the demise of the trading pit, traders have increasingly relied on computer terminals to access the market (Zaloom, 2006). Michael Lewis's (2014) bestseller *Flash Boys* describes the formation of a sectorial ignorance surrounding this new technology where traders remained oblivious to the physical processes by which algorithms and routers worked: behind the click of a button is a material meshwork of wires, cables, and circuit boards that help perform the global economy. Lewis explains how the "world clings to its old memorial picture of the stock market because it's comforting; because it's hard to draw a picture of what has replaced it; and because the few people able to draw it for you have no interest in doing so" (4). Screen essentialism obscures the simple fact that, for the digital to be enacted, information takes time to travel across distances in different forms (radio waves, electricity, light) through varying mediums (air, copper, plastic). So data not only governs space-time but is also mobile through it, no matter how unfathomably small the timeframes of movement appear to be (Zook et al., 2004; Zook, 2006).

The infrastructural ignorance towards the geographies of algorithms presented an opportunity for HFT firms to set up hardware in close proximity to the data centres feeding information to traders on Wall Street. This allowed coders to 'cheat' the system by sending and receiving data more quickly (by fractions of a second) than any stockbroker in the city. Programmers designed algorithms to intercept and read buy orders for stocks. When a buyer made a bid to an exchange the algorithm would beat that order and purchase it; then, with ownership of the stock, the algorithm could sell it to the same buyer who made the initial order for a fractionally higher price. Here, traders on Wall Street fell victim to an extremely costly form of screen essentialism as HFT firms 'sapped' billions of dollars from the economy. Even as early as 2012 algorithms administered 70 per cent of public stock market trades (Steiner, 2012). Pensions, mortgages, shares, stocks, and individual retirement accounts have become increasingly mediated by code. At the same time, the story of *Flash Boys* demonstrates how the actions of humans, who pull the algorithmic strings of the economy in the background, should not be neglected. In "order to work, algorithms must exist as part of assemblages that include hardware, data, data structures (such as lists, databases, memory, etc.), and bodies' behaviours and actions" (Terranova, 2014).

Like many infrastructures, algorithms often go unnoticed until they break and systems seize up (Star, 1999; Star & Strauss, 1999; Graham & Thrift, 2007; Jackson, 2014).[12] Events like the 2010 Flash Crash, where 9 per cent of the world's market value briefly disappeared thanks to malfunctioning HFT algorithms, personify this. Such a reliance on code has created a degree of anxiety surrounding the growing dependency on machines in an increasingly automated society

(Stiegler, 2016). Other accounts, however, are more sobering: Armin Beverungen and Ann-Christina Lange (2017) describe financial markets as human-machine ecologies, recognising how the relative simplicity of HFT algorithms demands consistent attention from programmers. This perspective ensures markets "do not resemble the bleakest visions of cybernetic control" (Beverungen and Lange, 2017). It is important for algorithmic geographies to account for these human-machine ecologies where apparently dissociated material phenomena can become notable factors—for example, in London microwave transmissions are used to send market data through the air because they work particularly well in drizzle (Mackenzie, 2014). Digital theorists must recognise the human and non-human materials 'hiding behind,' but enacting, screens.

Appendix 13: Copycat Cryptocurrencies

Such a multiplicity of political, technical, and economic discrepancies between the people building cryptocurrencies has led to the generation of over 1,200 different altcoins to date. To put the size of altcoins into perspective, on the 7th January 2018, the market capitalisation of all cryptocurrencies rose to $813.87 billion USD, with Bitcoin accounting for $276.63 billion. Duplicating source code, however, is common: one-third of projects on the code repository GitHub are copies (Mackenzie, 2018). But they also often carry alterations: organisational forking is the reason why altcoins usually carry different characteristics to Bitcoin. For example, Litecoin (often referred to as the silver to Bitcoin's gold) has a lower block rate of around 2.5 minutes (as opposed to Bitcoin's 10 minutes), allowing it to facilitate more transactions in a given amount of time. Litecoin was also designed to improve upon Bitcoin by running on a different hashing algorithm called scrypt (instead of SHA256), which technically makes mining less energy-intensive by favouring high-speed RAM for hash generation as opposed to raw CPU power. Theoretically, this changes the cryptoeconomic framework of the cryptocurrency because accumulating ASIC mining chips, in order to boost CPU power and scale up the productivity of mining rewards, becomes a fruitless technique.

In essence, these tweaks should make Litecoin a greener cryptocurrency—a common critique of Bitcoin is the amount of electricity that is by default needed, or as critics say, 'wasted,' in order for it to function (Buterin, 2012; Limer, 2013; Malmo, 2017; Hern, 2018). Technically, requiring high-powered forms of RAM makes the mining process more akin to one CPU per vote (originally outlined in Satoshi Nakamoto's Bitcoin whitepaper) and gives less room for a Litecoin mining arms race, thereby reducing the amount of energy needed to secure the network. However, companies like Alpha Technology have since designed ASICs for scrypt hashing so that a similar pattern of scaling is reproduced for Litecoin

mining (Southurst, 2014). Other spinoffs like Primecoin devote their "proof-of-work process to find prime number chains of mathematical interest," thus creating an additional use for mining (Brunton, 2015, 168). Elsewhere, developers have used different proof mechanisms, such as proof-of-stake (NXT and Peercoin) and proof-of-space (SpaceMint and Burstcoin), to secure cryptocurrencies. These solutions are designed to bypass the energy-intensive limitations seen in Bitcoin's proof-of-work system.

Appendix 14: The History of Open Source

The specific investigation of Bitcoin's political history in Chapter 4 demonstrates how its code is a repository of social norms and values (Berry, 2011; Coleman, 2012). The cypherpunks I outlined there often held similar values to many of those associated with the open source software movement—in fact, both of these intellectual groups largely overlapped. As a means of production, open source grew out of what was initially referred to as "free software" and was said to emerge as a "genuine grass roots revolution" (DiBona et al., 1999, 5):

> Free Software's roots stretch back to the 1970s and crisscross the histories of the personal computer and the Internet, the peaks and troughs of the information-technology and software industries, the transformation of intellectual property law, the innovation of organizations and 'virtual' collaboration, and the rise of networked social movements. (Kelty, 2008, x)

The movement positioned itself against the increasing control of propriety software utilised by corporations in order to create an ecosystem in code development resembling the intellectual style of science (Deek & McHugh, 2008): an open, experimental, and consensual form of knowledge production (Berry, 2004). Practitioners initially existed in dislocated dribs and drabs but became formalised by Richard Stallman with the Free Software Foundation in 1985 that emerged as a rallying cry to make software free from both constraints and cost (Deek & McHugh, 2008; Kelty, 2008). Producing this proprietary system provided a form of 'commoning'—exemplified by open access—for technological development (Raymond, 1998). The political premise regarded software as a public good, harnessing a discourse surrounding "code, freedom, power, progress, community and rights" (Berry, 2004, 71). To ensure the best quality of code, and for advancements to become most beneficial to society, it was said that software should be accessible to an open, cooperative community (Kuhn & Stallman, 2001).

Free software groups first began to align with the Advanced Research Projects Agency Network (ARPANET): an early packet-switching system that used the TCP/IP protocol and later became a cornerstone for the Internet. ARPANET's "electronic highways brought together hackers [from] all over the U.S. in a critical mass; instead of remaining in isolated small groups each developing their own ephemeral local cultures, they discovered (or re-invented) themselves as a networked tribe" (Raymond, 1998, 16). Gradually, free software gained traction exemplifying a "considerable reorientation of knowledge and power in contemporary society . . . with respect to the creation, dissemination, and authorization of knowledge in the era of the Internet" (Kelty, 2008, 2). Yet some ideological friction occurred; this was instigated by Eric Raymond in 1997 and resulted in a divergence (or forking) between free software and open source software.

Raymond "was concerned that conservative business people were put off by Stallman's freedom pitch, which was, in contrast, very popular among the more liberal programmers" (Perens, 1999, 173). Opposing the anti-government and anti-centralist rhetoric (Berry, 2004), open source was conceived to "market the free software concept to people who wore ties" (Perens, 1999, 173). The countercultural New Left and the entrepreneurial New Right of the Californian Ideology locked horns again here. David Berry (2004) explains how the Free Software foundation used a discourse of ethics and a discourse of freedom (Stallman, 1999), whereas the open source movement draws more from discourses of neoliberalism and technical efficiency (Raymond, 1998). Both strands helped create projects like the Linux Kernel (an operating system assembled under free and open source software development and distribution) grow into the business world to become the most widely ported operating system in global computer hardware platforms—here the "neoliberal tinge" of openness is relatively clear as capital accumulation becomes a driving force behind the open source model under laissez-faire markets (Tkacz, 2015, 177). Although there are distinctions between the free and open source software movements, they have often shared a similar trajectory, as well as the same authors and coders (Berry, 2004). Looking past their differences, both have contributed to the "increased visibility of code as an object of economic, legal, political, artistic and academic interest" (Mackenzie, 2006, 21).

Appendix 15: Understanding Version Control

Version control systems are designed to store information for every file as well as the general project structure in what is called a repository, where "several parallel lines of development, normally called branches, may exist" (Ruparelia, 2010, 5). This model "keeps track of every modification of the code in a special kind of

database. If a mistake is made, developers can turn back the clock and compare earlier versions of the code to help fix the mistake while minimising disruption to all team members" (Atlassian, 2017).

Previous architectures, such as Concurrent Version Systems (CVS) and Subversion (SVN), relied on a client-server model so that each developer worked on their own local copy of the source code. Once programmers had edited their version they would have to push/commit their changes direct to the central repository without a chance for any other team members to see their changes. Because each developer would make changes to copies of the original files, as opposed to direct changes to the central source code itself, updating the many conflicting versions was a manual-based process that made editing laborious, confusing, inefficient, time-consuming, and prone to error. To resolve these problems, *distributed* version control was introduced bringing concurrency into software production. This is akin to all programmers having access to the central repository and the full history of the code allowing team members to work offline with full functionality. No changes can be seen, however, until an individual developer connects to the network and pushes his or her code to the other repositories for review. Such 'distributed' systems allow everyone to work on the same source code at once. Ultimately, this environment of collaboration "protects source code from both catastrophe and the casual degradation of human error and unintended consequences" (Atlassian, 2017). As such, distributed version control systems have become an integral element of everyday practice for software development teams.

Git is a "particularly powerful, flexible, and low overhead version control . . . [originally] invented by Linus Torvald to support the development of the Linux kernel" (Loeliger & McCullough, 2012, 1). It was designed to facilitate distributed development, scale to handle thousands of developers, perform quickly and efficiently, maintain integrity and trust, enforce accountability, create immutability, sustain atomic transactions, support and encourage branched development, provide complete repositories, foster a clean and integral design, and harness freedom (Loeliger & McCullough, 2012). Like Bitcoin, Git is secured with a cryptographic hashing algorithm that "protects the code and change history against both accidental and malicious change and ensures that the history is fully traceable" (Atlassian, 2017). This is like having constant and authentic backups of every alteration made by all developers working on the project.

GitHub "provides services for individuals and teams to manage public and private repositories via Git" (Begel, 2013, 52). In its 12 years of operation, it has attracted a diverse mix of novice and professional programmers (see Gousios et al., 2013). The blend of code repository and social networking has become compelling for developers (Begel, 2013).[13] While Gits are not unique to open

source software, GitHub actively promotes openness via its carefully crafted revenue stream: the company provides free hosting for all projects with open access while their economic model demands paying subscribers, who develop code on the website privately, cover the costs of everyone else. This allows GitHub to "function as an element in a wider platform configuration" (Mackenzie, 2018, 48): it turns the social act of coding collaboration into (future) revenue streams via a process known as platform capitalisation, which broadly looks to transform on-boarded networked practise into financial assets (Mackenzie, 2018; see Chapter 8). However, free hosting for open projects with open access is also a political move to increase the transparency of software and has allowed the open source software community to grow exponentially.

Appendix 16: The Bitcoin Foundation

The Bitcoin Foundation came about as a self-(s)elected organisation of prominent figures within the Bitcoin community including Bitcoin Core Lead Developer Gavin Andresen, BitInstant CEO Charlie Shrem, Mt. Gox CEO Mark Karpelès, and early Bitcoin venture capitalist Roger Ver. In true open source fashion, the Bitcoin Foundation bylaws were posted on GitHub to open them up to scrutiny and suggestions from the wider Bitcoin community. Written there is the following passage: "the purposes of the Corporation include, but are not limited to, promotion, protection, and standardization of distributed-digital currency and transactions systems including the Bitcoin system as well as similar and related technologies" (Bitcoin Foundation, 2012). In a more political tone it continues: "[t]he Corporation shall promote and protect both the decentralized, distributed and private nature of the Bitcoin distributed-digital currency and transaction system as well as individual choice, participation and financial privacy when using such systems" (Bitcoin Foundation, 2012).

The Bitcoin Foundation has always been clear about their motives: "[w]e believe that money supply should not be used as an instrument of monetary policy as inflation destroys value & encourages unsustainable consumption" (Bitcoin Foundation, 2012). Further, "[w]e believe that centralization of the money supply leads to corruption & exploitation" (Bitcoin Foundation, 2012). Yet, perhaps counterintuitively to Bitcoin's early politics, a significant role of the Foundation was to give nation-state regulators a central body to approach in order to deal with issues relating to the emerging technology. With Bitcoin's links to Silk Road, this was supposed to allow the community to "separate itself from the virtual currency's controversial past" (Popper, 2015a, 138).[14]

After conducting and analysing a number of surveys among the Bitcoin community, the Foundation eventually turned its attention to supporting the development of the Bitcoin software as opposed to its outreach programs (Higgins, 2014). Supported by donations from companies and other members, these funds were redirected to pay Bitcoin Core developers who could then spend more time working on the code. However, the existence of the Bitcoin Foundation has not been without its controversy: board members have been arrested and imprisoned, it has faced insolvency, and has been repeatedly accused of mismanagement (Parker, 2015). Despite generous donations of bitcoins, the Foundation came close to bankruptcy in 2015 and retracted its role as financier for Bitcoin Core (Parker, 2015; Wong, 2015).

Appendix 17: A Fragmented Global Monetary System

In Chapter 2, following in the footsteps of economic geographers, I outlined how money is produced through dense networks of practice between specific people so that its different forms are patchworked across the world in an independent, yet interconnected, manner. Different financial services utilise strategies and technologies to streamline the gateways between them, profiting in the process by taking a fee (syphoning off quantities of flowing money). Almost serendipitously, I experienced this monetary fragmentation when I first landed in San Francisco in early 2015 to begin my research within the Bitcoin start-up economy. On arrival, I immediately needed to transfer $5,000 AUD to an American bank account so I could start paying rent to my new landlord—this would be done with the financial tool of a bank cheque sent monthly to their home address via the postal system (sending payments via 'snail mail' remains a common method for settling rent in the United States).

I made my way to Market Street and opened an account with Wells Fargo before returning to my apartment to log on to the online banking service of my Australian bank, Bankwest. Halfway through the transfer procedure I was met with error messages due to my 'international payment limit' being set to zero (something my bank had failed to tell me needed changing when I had let them know of my intentions the week before). To change this limit, I had to type in a code sent via SMS (short message service) to my Australian mobile telephone number, something I no longer had, in order to authenticate my identity. To solve this problem, I topped up credit on my Skype account and made a long distance telephone call to Australia. After an arduous period filled with efforts to prove my identity, I was directed to an International Money Transfer (IMT)

form to fill out and, the advisor told me, "fax back." As a researcher in my mid-twenties, I neither knew where I would find a fax machine or, indeed, how to operate one. We finally agreed that scanning the document and emailing it to Bankwest would work just as well. I do not carry a digital copy of my Bank State Brach and account number so I had to call a friend in Australia, who was looking after my things in storage, and ask him to send me these details. I then filled in, scanned, and sent the IMT form to Bankwest via email. I had been informed my bank would attempt to call me three times to confirm the transaction and if they could not get through it would be cancelled.

No call came. Meanwhile I was withdrawing $400 USD from ATMs per day (the limit for daily withdrawals) with my Bankwest debit card and depositing the cash into my Wells Fargo account in person (taking the transaction fee hit each time). A few days later I received an email from Bankwest saying my transaction had been cancelled because the telephone number I provided did not match the number they had for me in their database. A stern email and a Skype call (consisting of a rigorous identity check) later, Bankwest finally agreed to process the transaction. A few business days went past and the money appeared in my account—precisely, 11 days, plus many banking fees, after I had first tried to make the money transfer. This anecdote will for many Bitcoin proponents personify the problems that currently exist regarding centralised systems of banking and finance: a reliance on third parties whose permission is required in order to send money and who use traditional means for proving identity (however, a similar system of control is replicated by many Bitcoin wallet and exchange companies—see Chapter 6).

The process by which Australian dollars vanished from my Bankwest account and reappeared as US dollars in my Wells Fargo account relies heavily on the SWIFT (Society for Worldwide Interbank Financial Telecommunication) network formed in 1977—this name may now be starting to garner a degree of irony in the light of quicker modern financial technology companies like TransferWise. SWIFT is simply a standardised messaging system: its "primary role [is] to carry the messages containing the payment instructions between financial institutions involved in a transaction" (Scott & Zachariadia, 2013, 43). Bankwest uses the SWIFT interface to communicate with Wells Fargo, initiating a "sequence of events that involves a number of financial institutions and technologies such as banks, clearinghouses, data transmission links, and electronic accounting systems" (Scott & Zachariadis, 2013, 41). SWIFT essentially sends out payment orders to the required parties needed to complete the transaction, which must be settled by the corresponding accounts institutions have with each other; it caters for a flow between these different centralised pools of money. Depending on the web of banking relationships this can involve up to four intermediary banks (who all take a fee), underpinned by clearing houses (that authorise

end-of-day transfers between banks in bulk), all of which add to the delays and costs of international money transfers (Wilson, 2014).

This brief narrative describes the interlocking yet somewhat bordered and separated global monetary systems that are, at times, brimming with friction. It was with a degree of irony that I was visiting California to explore a digital currency designed to make this convoluted system obsolete yet I was nonetheless caught in the fractured monetary networks that reside in the sticky webs of bordered territories. This experience seemed to epitomise the "dated" and "broken" global financial system Bitcoin proponents, like Andreas Antonopoulos (2014), had been criticising.[15] Meanwhile, a host of start-up companies were gathering in the San Francisco Bay Area around me, poised to subvert the banking operations that had caused me so much grief. A segment of them shared something in common: the utilisation of distributed algorithmic protocols.

Appendix 18: Flooding the Bitcoin Network

Open blockchain networks are susceptible to a form of protest similar to a DoS attack. Costs associated with making transactions are supposed to discourage such behaviour—as outlined by Adam Back's hashcash (see Chapter 3)—but it can still persist. The Bitcoin block size limit of 1 MB was not part of the original Bitcoin code but was added in 2010 to control spam by preventing "would-be attackers from overloading the network with a flood of cheap transactions" (Smith, 2017). Ironically, however, this had the opposite effect in 2015. As the block size debate ensued (see Chapter 5), an unknown entity began bombarding the network with low-value transactions in an attempt to clog up and slow down the rate of transactions being processed. I was working out of Level39 in Canary Wharf at the time, where a Coinjar employee described the stunt as a "protest attack," designed to practically illustrate why block sizes needed to be raised.

I experienced the effects of this demonstration at a London Bitcoin meet-up, Coinscrum, when I met a visiting entrepreneur from the United States. He was in the country for a short amount of time and needed some pound sterling, so I agreed to exchange him £100 GBP for the equivalent value in bitcoin. After I withdrew some cash from a nearby ATM, he opened a Bitcoin wallet application on his mobile phone and scanned a QR code representing one of my own Bitcoin wallets. Given the saturation of the mempool, he decided to make the miner transaction fee higher than usual to encourage them to include it within an upcoming block and therefore beat the rest of the network traffic. I handed over the cash and waited apprehensively for my transaction to be mined into a block, which took around 50 minutes.

Appendix 19: The History of Silicon Valley

Popular stories of Silicon Valley's birth hail to the legends of William Hewlett and David Packard, who started the ICT company Hewlett Packard during 1938 in one of their parents' garage in Palo Alto (Lowen, 1992; Leslie, 1993; Kenney, 2000). Other tales describe William Shockley's foundation of Shockley Transistor Company in 1955, whose spinoff, Fairchild Semiconductor, for a time dominated the region's silicon chip productivity (Kenney, 2000). However, these accounts truncate the historical economic geography of Silicon Valley. In actual fact, this dates back to the turn of the twentieth century when a small-scale but vibrant electronics industry emerged in the larger San Francisco Bay Area (Sturgeon, 2000). Here, companies experimented with radio, television, and military electronics (Sturgeon, 2000). Other technology firms were also established in the Bay Area during World War II to support Allied troops (Sturgeon, 2000; Kenney & von Burg, 2001). It was not until the post-war period, however, in a relatively localised rural area of Santa Clara Valley, California—north-west of San Jose—that the real industrial prowess of Silicon Valley first took root (Saxenian, 1981; Gershon, 2014). From 1944 to 1949 the fields and orchards of tomatoes, peas, prunes, apricots, and pears, synonymous with the area, were uprooted to increase industrial diversification and make way for tract housing, industrial plants, shopping centres, and 80 new industries (Scott, 1985). The previously rural area became known as Silicon Valley, from the silicon chips that it bore (Hoefler, 1971), and grew into a sprawling suburbia whose seemingly endless interconnecting grid of roads and rectangular buildings took on the look of the integrated circuits it produced (Johnston, 1982).

The federal funding of nearby electronic equipment laboratories, the large local market of war-related semiconductor-hungry aerospace and electronics enterprises, and skilled scientific and engineering labour emerging from local universities such as Stanford, allowed the industry to thrive (Saxenian, 1983).[16] Accumulated capital from semiconductor firms, such as Fairchild, and their subsequent reinvestments in new ventures (in tandem with added capital from the proximate West Coast financial centre of San Francisco), created a fertile environment for technological start-up companies (Saxenian, 1983). In the latter part of the 1980s, however, semiconductor production dwindled in the area with increased competition from overseas. Many low-paid manufacturers, predominantly ethnic minorities, were laid off and by 1993 Silicon Valley had begun haemorrhaging jobs while losing its cultural edge for attracting talent worldwide (Khanna, 1997).[17]

Software development proved to be a more opportunistic and profitable sector and the local economy started shifting due to a fresh injection of venture

capital (Khanna, 1997). This money followed a moving trajectory from hardware production to companies facilitating computer systems and application software (Burnham, 2007). A subsequent move towards new media companies, that sought to capitalise from business models built around the Internet, left the primary sector of semiconductor production in decline (although headquarters often remained in the Valley). While hardware manufacturing dwindled, the opportunity to work on new software services dragged world-class programmers from across the world to the San Francisco Bay Area and the infrastructural capacity to cater for high technology firms grew up around them. The rise of software-based innovation led to a resurgence of Silicon Valley productivity (Arora et al., 2010), while the commercialisation of the Internet, from 1995 to 1998, reversed the region's economic decline (Kenney, 2000). Production would no longer come from manufacturers building computers on the assembly line but programmers working on those machines (increasingly built outside of Silicon Valley and the United States).

From 1995 to 2000, roughly $65 billion USD of venture capital was pumped into the area (mainly within the New Economy), creating a secondary wave of growth including 172,000 high technology jobs (Mann & Luo, 2010). When the dotcom "boom" proved to be a bubble, only a few companies, like Yahoo! (Sunnyvale) and eBay (San Jose), survived the wreckage (The Economist, 2001). However, many that did endure became powerhouses in the sector. A third wave of venture capital arrived in 2004 with the development of Web 2.0 companies (GlobeNewswire, 2007; Mann & Luo, 2010). Silicon Valley then added a plethora of social networking sites to its repertoire including Facebook, Twitter, and LinkedIn. Its newfound economic strength was exemplified when it became one of the only regions in the world hardly affected by the 2008 global financial crisis (Miller, 2008; Williams, 2013)—although some cuts in spending were made in anticipation of a downturn (Tam et al., 2008).

As the technology industry's production diversified from hardware to software, Silicon Valley started to occupy a vast geographic and mental space up the San Francisco peninsular and around the Bay Area (Kenney & von Burg, 2001). Consequently, although Silicon Valley is a technopole on an international level (Saxenian, 1996; Sotarauta & Spinivas, 2005; Woodward et al., 2006), it is more of a technosprawl locally. In fact, the southern part for the Valley now pulls in more commuters from San Francisco than the other way around (Schafran & Walker, 2015). The city has thus been suburbanised by its own suburbs—epitomised by the iconic Google and Facebook shuttle busses carrying young professionals from the city to their Mountain View head offices (Schafran & Walker, 2015). Meanwhile, technology companies like Twitter, Airbnb, Dropbox, and Uber have moved into the city, making San Francisco a locational and metaphorical extension of Silicon Valley (McNeill, 2016).

Appendix 20: Technopolitics

On the one hand, the libertarian vision of technology as a means to free people from place-specific politics has some empirical grounding. For example, it has been noted how the communication facilitated by online social media sites during the Arab Spring allowed for the cohesion and mobilisation of political protests (Khondker, 2011; Howard et al., 2011; Wolfsfeld et al., 2013). However, this technologically enabled dissent is nothing short of political action itself. Consequently, the utopian vision of digital realms becoming politics-free is utterly nonsensical. Social media platforms, for example, have been moulded into tools of control. The role Facebook has played in the Israeli occupation of Palestine exemplifies this. Here, the government of Israel uses the social media site as a surveillance tool over the Palestinian population (McKernan, 2016; Nashif, 2017). Facebook has also been complicit in silencing Palestinian voices through the censorship of online content and the permanent suspension of journalist accounts (Alareer, 2016; Al Jazeera, 2017). Far from Peter Thiel's (2009) claim of technologies fostering "communities not bounded by historical nation-states," in this case one of his very own ventures is tightly tied up with spatial sovereignty and colonial rule. So, to suggest digital environments become a "new world" or "space," placing the technological in an oppositional "race" with the political, is both a fantasy and a fallacy.

Facebook has also recently been caught up in a storm of international controversy over the privacy of user data and its role in servicing advertisements for commercial and political campaigns. In 2018, the cofounder and CEO of Facebook, Mark Zuckerberg, made a testimony to the US Congress "prompted by the revelation that Cambridge Analytica, a political consulting firm linked to the [Donald] Trump campaign, harvested the data of an estimated 87 million Facebook users to psychologically profile voters during the 2016 election" (New York Times, 2018). The same technique was also applied by the opposing party of Hillary Clinton and has been linked to the Brexit campaign in the United Kingdom. This mobilisation and monetisation of data demonstrates how technology remains deeply entrenched within the political sphere. It is nowhere near as innocent or neutralising as the Californian Ideology suggests.

Appendix 21: "Death by Gentrification"

Anyone who has lived in San Francisco will know it is relatively difficult to meet someone who was actually born there; with many cultural, political, and economic pull factors, the city can appear a xenolothic space assembled through

national and international migration. The topography is therefore littered with competing and overlapping San Franciscan territorial identities, contributing to its long historic morphogenesis (Godfrey, 1985). Perhaps the most tumultuous addition to the melting pot has been the rapid intrusion of well-paid technology company employees who have had a tremendous impact on the city's physical and social morphology.

In the latter half of the 1990s, San Francisco became awash with dotcommers: a new type of "young, moneyed, hip, professional" striving to profit from Internet businesses whose spatial practices changed the urban landscape in the form of "chic bars and electric boutiques, postindustrial apartments, and sleek office spaces" (Centner, 2008, 193). In the Mission District, a bizarre colonisation of street space occurred in the form of illegal parking practices conducted by dotcommers who would leave their sports cars "bumper to bumper" along Valencia Street—the parking fines meaning little to the "new economy revellers [who] sipped unorthodox martinis and made new connections with other internet workers in the overflowing bars of the district" (207). Consequently, the Mission became a site of cultural backlash to these new patterns of consumption (Nieves, 2000), which continues to this day.

For example, in 2016, the San Francisco–based author Rebecca Solnit released an article titled "Death by Gentrification" telling the story of a local 28-year-old Mexican man, Alejandro Nieto, who was shot dead by law enforcement (Solnit, 2016). The police were originally called by "white newcomers" who saw Nieto as a "menacing outsider" (Solnit, 2016). The article describes a cultural disconnection in the urban environment as a rich techie monoculture sweeps through the poor local multiculture of the Mission. Thus the title holds a duplicity of meaning. To Solnit, Nieto's death is a tragic consequence of a much wider metaphorical necrosis of San Francisco's cultural soul via gentrification, which caters for the technology industry. This "violent" process, Solnit argues, turns a complex urban environment into a homogenous and exclusionary place (Solnit, 2014a, 2014b, 2016a).

Appendix 22: Post-Dotcom Vogue

Simplistic aesthetics also echo around the rest of Silicon Valley and saturate the work spaces of (new) technology companies globally. They became popular in the dotcom era due to the limited finances of start-up companies and the availability of large urban buildings—such as lofts and old industrial warehouses—that had lost their primary function with the deindustrialisation of city centres (Ross, 2003; Indergaard, 2004). Here, however, there was a contrived 'unfinishedness'

about the place, regurgitating a romanticism of what 'start-updom' should look like. The exposed bricks, open pipes, and naked fittings looked as though they had been searched for or placed there instead of being left uncovered due to the added costs of concealing them. While the iconic traditional imagery of start-ups once emerged as a spatial necessity, underwritten by a lack of funds, it is purposefully being reproduced today in its own historical image to promote a sense of authenticity and creativity. Although many companies now have the capital to escape from techno-bohemia, it lives on through the material culture of office space. This is done to create a (pseudo)impression of innovation—in direct opposition to the 'stuffy' and 'less disruptive' workplaces of traditional firms. In other words, an aesthetic (in)authenticity nostalgic of past commercialism is mimicked to signal originality, inventiveness, and future success.

Appendix 23: The Aspirations of PayPal

When Peter Thiel returned to his old university, Stanford, to "deliver a guest lecture on the link between market globalization and political freedom" (Jackson, 2004, 8), he crossed paths with 24-year-old programmer Max Levchin, who had recently sold his start-up NetMeridian to Microsoft. The pair began meeting in Palo Alto before forming Fieldlink, which would later become Confinity, X.com, and finally PayPal.[18] The company secured funding from Nokia Ventures and Deutsche Bank and began rapidly pulling in talent (largely from Thiel's Stanford alumni network) to their office, 165 University Avenue in Palo Alto, which had previously housed Google and Logitech (Jackson, 2004, 8). In his book *The PayPal Wars* the company's 27th employee, Eric Jackson (2004), recalls a speech made by Thiel to the team:

> Everyone wants to invest in this company! And why not? We're definitely onto something big. The need PayPal answers is monumental. Everyone in the world needs money—to get paid, to trade, to love. Paper money is an ancient technology and an inconvenient means of payment. You can run out of it. It wears out. It can get lost or stolen. In the twenty-first century, people need a form of money that's more convenient and secure, something that can be accessed from anywhere with a PDA [Personal Digital Assistant] or an Internet connection.
>
> Of course what we're calling 'convenient' for American users will be revolutionary in the developing world. Many of these countries' governments play fast and loose with their currencies. They use inflation and sometimes wholesale currency devaluations, like we saw in Russia

> and several Southeast countries last year, to take wealth away from their citizens. Most of the ordinary people there never have an opportunity to open an offshore account or to get their hands on more than a few bills of stable currency like U.S. dollars.
>
> Eventually PayPal will be able to change this. In the future, when we make our service available to outside the U.S. and as Internet penetration continues to expand to all economic tiers of people, PayPal will give citizens worldwide more direct control over their currencies than they ever had before. It will be nearly impossible for corrupt governments to steal wealth from their people through their old means because if they try the people will switch to dollars or Pounds or Yen, in effect dumping the worthless currency for something more secure.
>
> —(2004, 25–26)

The libertarian, decentralist rhetoric in this passage is extremely clear: PayPal is elevated as an enterprising saviour of citizens from the evils of centralised governments.

Appendix 24: National Blockchain Governance

In 2017, Nathan Heller published an extremely poetic article in the *New Yorker* titled 'Estonia, the Digital Republic.' It describes how Estonia is using blockchain technology to revolutionise many of its services from "legislation, voting, education, justice, health care, banking, taxes, policing, and so on . . . across one platform, wiring up the nation" (Heller, 2017). Chipped ID cards and passwords allow citizens access to the online platform X-Road, supported by Guardtime's Keyless Signatures Infrastructure 'blockchain.' Here, data is not centrally held but instead "links individual servers through end-to-end encrypted pathways, letting information live locally. Your dentist's practice holds its own data; so does your high school and your bank. When a user requests a piece of information, it is delivered like a boat crossing a canal via locks" (Heller, 2017). As other countries like Finland, Moldova, and Panama begin to use platforms like X-Road, interoperability between these nation states is achieved by channeling secure information (like prescriptions from pharmacies) across borders (Heller, 2017). "Every time a doctor (or a border guard, a police officer, a banker, or a minister) glances at any . . . secure data online, that look is recorded and reported. Peeping at another person's secure data for no reason is a criminal offense" (Heller, 2017). In theory, this provides greater control over personal data for individuals. At the same time, however, complications could arise as these new architectures intersect with general data protection regulation (Sullivan & Burger, 2017).

A digital 'residency' program allows "logged-in foreigners to partake of some Estonian services, such as banking, as if they were living in the country" (Heller, 2017). Here, "heat is taken off immigration because, in a borderless society, a resident need not even have visited Estonia in order to work and pay taxes under its dominion" (Heller, 2017). Indeed, "[w]ith so many businesses abroad, Estonia's startup-ism hardly leaves an urban trace" (Heller, 2017). Venture capitalist Tim Draper is heavily involved in Estonia's start-up scene. To him, the country's progressive stance towards decentralism is a revelation because it creates a global market for brain power and capital, which governments will have to compete for (Heller, 2017). This transforms existing spatial arrangements, reinforcing sovereignty in new ways. While the Estonian government maintains control over its monetary and legal territory, it employs new methods for administration in a manner that can help its economy operate outside of its geographic territory. While citizens are in control of their own data, the issues raised in this book expound and explicate the requisite levels of critical awareness researchers need to harness when following the connections within, and between, such platforms to understand interdependent levels of power.

Notes

1. The first forms of writing found in archeology have been allocated to economic transactions.
2. Heredity and land ownership still play a significant role in modern economic wealth distribution but banking helped transform the social organisation of finance.
3. For a deeper discussion of free banking and its evolution, see Charles Goodhart (1991), especially Chapter 2.
4. It should be noted that the period in the United States from 1837 to 1864 known as the Free Banking Era is somewhat of a misnomer as the country was based on various state banking systems that practised "free banking" laws, so that government restricted certain operational procedures (Kenneth, 1988; Rockoff, 1989; Bodenhorn, 1990; Economopoulous & O'Neill, 1995). In this sense bank failures have also been attributed to regulation procedures as opposed to the systematic failure of free banking itself (Calomiris, 2010). The relationship between governments and banks in the nineteenth century is therefore much more complicated than this book has room for. For further discussion, see Arthur Rolnick and Warren Weber (1983; 1984; 1988).
5. Michigan banks were notoriously known for depicting animals on their issued banknotes as well as practising fraudulent banking operations, giving rise to the term "wildcat" banks that were "marked by their lack of stability and suspect notes" (Markham, 2002).
6. As new banks could not issue banknotes and existing banks could not expand their issue, private banknotes were eventually phased out.
7. The staggering hyperinflation in Zimbabwe of 471 billion per cent in 2008, caused by the massive amount of fiat currency printing orchestrated through the overarching dominance of the Zimbabwean government over its central bank, shows how dangerous these relationships can be for a country's people (Coltart, 2008; Hanke, 2008; Hanke & Kwok, 2009).
8. To reinforce this point, British currency is still referred to as 'pound sterling,' a terminological hangover from 775AD when 240 silver Saxon pennies weighed a pound (lb)—the same weight in silver would be worth roughly £203 GBP at the time of writing.

9. It is worth mentioning that less and less of global money is actually 'printed' in the paper-and-ink sense but rather the supply is increased through digital bank balances.
10. Another researcher could find alternative actor-networks that are just as important for blockchain culture, history, politics, economics, and geographies.
11. Altering Bitcoin's code is a complex procedure outlined by Chapter 5.
12. Brain Larkin (2013), however, suggests that this quality of infrastructure is a "partial truth": "[i]nvisibility is certainly one aspect of infrastructure, but it is only one and at the extreme edge of a range of visibilities that move from unseen to grand spectacles and everything in between" (336). For example, people who work on maintaining infrastructures are constantly aware of their existence.
13. Eric Raymond (1998), a key pioneer of the open source software movement, once stated that the revelations of open source projects are not technical but sociological.
14. Bitcoin has also been linked to a number of hacks where computers have been frozen and locked with encryption software. In these circumstances, attackers will only unlock their victim's machines after a ransom of bitcoins is paid (PBS, 2015). Additionally, the infamous, yet anonymous, hacker(s) who leaked naked photos of over 100 celebrities (after infiltrating their cloud storage) on the website 4chan in 2014 asked for donations of bitcoins in return for their efforts (Arthur & Topping, 2014).
15. However, the slow processes of traditional financial technologies are often intentional (DuPont, 2019; see Chapter 8).
16. Stimulated "after the Second World War by military contracts awarded to electronic plants, the burgeoning industrial chain grew rapidly in the 1960s when the National Aeronautics and Space Administration established its Ames Laboratory at Moffet Field and the Atomic Energy Commission supported the construction of a giant linear accelerator at Stanford University" (Scott, 1985, 311).
17. Although semiconductor productivity has continued to decrease, a degree of hardware manufacturing remains in Silicon Valley today, although this tends to be limited to more specialised products such as prototype production (Caulfield, 2012).
18. A merger with Elon Musk's X.com was initiated so both companies could outgrow their competitors together.

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