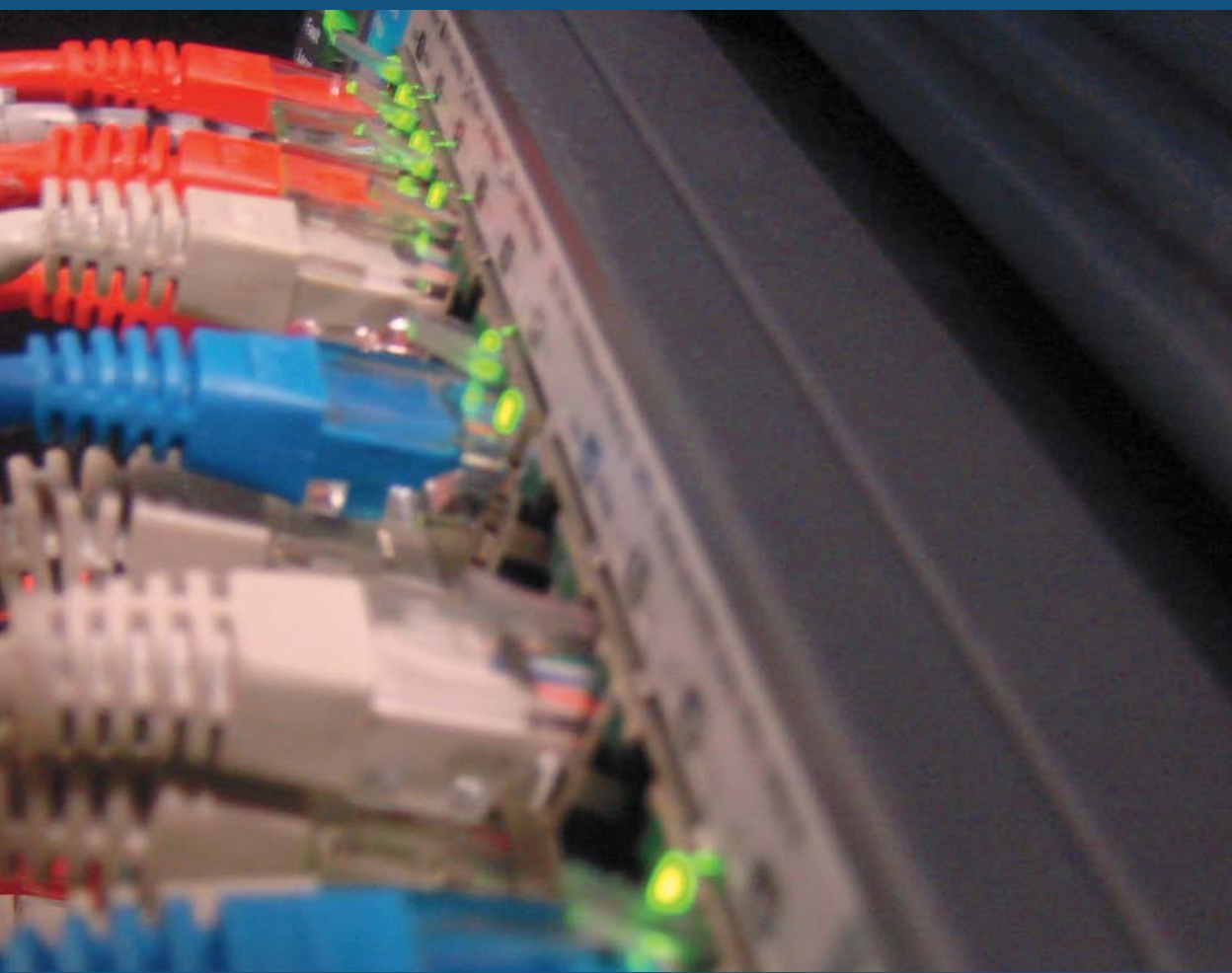
Crowds, Coins and Communities

Digital Entrepreneuring in Emerging Financial Infrastructures

Claire Ingram Bogusz



STOCKHOLM SCHOOL OF ECONOMICS

Crowds, Coins and Communities

Digitalisation, or activities mediated by digital technologies, is more than the movement of pre-digital practices to digital environments. Instead, it fundamentally changes underlying practices. This thesis studies digitalisation in the field of finance, as entrepreneurs reinvent existing financial infrastructures, piece by piece. It zooms in on the practices of digital entrepreneuring in digital infrastructures through case studies of crowdfunding and cryptocurrencies (and online communities).

It finds that digital entrepreneuring differs from its non-digital counterpart when it comes to legitimacy-building and consensus-building. This is because 1) distributed control of digital infrastructures affects how they evolve and are perceived; 2) code forks are used as an organising mechanism; 3) niche groups find, and cooperate with, each other more easily online; and 4) entrepreneuring practices cannot be severed from the digital artefacts upon which they rely.

It finds that being reliant on a digital infrastructure is not as democratising as previously theorised: relational practices (like stigma, the formation of standards, and cooperation) anchor entrepreneurs in their chosen digital infrastructures, which limits the options open to them.

The thesis is comprised of five papers and an introductory chapter. The introductory chapter delves into the overall contribution; the first two papers examine infrastructural artefacts' mediating role in organising, facilitating and constraining digital entrepreneuring, and the last three papers show how digital artefacts mediate in traditional areas of entrepreneurship research; namely in the formation of entrepreneurial legitimacy, in reacting to stigma, and in challenging established institutions through digital economic social movements.

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Claire Ingram Bogusz
Stockholm School of Economics

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To
Marcin,
Julian,
and the Mothership

Foreword

This volume is the result of a research project carried out at the Department of Marketing and Strategy at the Stockholm School of Economics (SSE).

This volume is submitted as a doctoral thesis at SSE. In keeping with the policies of SSE, the author has been entirely free to conduct and present her research in the manner of her choosing as an expression of her own ideas.

SSE is grateful for the financial support provided by the The Internet Foundation in Sweden, the Marianne and Marcus Wallenberg Foundation, the Hedelius Foundation, the Lars Hiertas Foundation, and the Infina Foundation, which has made it possible to carry out the project.

Göran Lindqvist

Director of Research
Stockholm School of Economics

Richard Wahlund

Professor, and Head of the
Department of Marketing and Strategy

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This research would not have been possible without the generous funding I received from the Stockholm School of Economics, The Internet Foundation in Sweden, the Marianne and Marcus Wallenberg Foundation, the Hedelius Foundation, the Lars Hiertas Foundation, and the Infina Foundation. Without these sources of financial support, neither the thesis nor attendance at the conferences that improved its contents would have been possible.

It would also not have been possible without the kind cooperation of those who agreed to be interviewed, both in Canada and in Sweden, for this thesis and related papers. It is hard to thank those who commented anonymously in forums, but I am grateful for the chance to use their comments as a data source. Many people also invited me into their "worlds" in order for me to understand my research field: to those people, thank you.

I was fortunate to spend time at the Desautels Faculty of Management at McGill University during my PhD. Emmanuelle Vaast not only invited me and hosted me during my time there, she has also been a supportive committee member and co-author, from whom I have learnt a great deal.

Marcel Morisse and Jonas Valbjørn Andersen, my other co-authors, thank you for late nights, intellectual arguments, and helping make this thesis a reality.

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Emelie Fröberg, I have no idea how you completed a PhD of your own while sharing an office with me—but you are an inspiration, and a great friend. Zeynep Yetis-Larsson, we speak less than I would like after you moved abroad, but it was always wonderful to be in the same boat as you. Assia Viachka, your infectious laugh is always welcome.

To my mother, who moved across the world to be with us, thank you for your presence, your moral support, and for being "infrastructural".

Marcin, I have no words for how much you mean to me, how much perspective you have given, and how lucky I am to call you my husband. Thank you for your support—and innumerable distractions, including my other love, Julian.

Knivsta, December 1, 2017

Claire Ingram Bogusz

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Chapter 1

Introductory Chapter

Introduction

> In the middle of his presentation, a grey-haired senior partner stood up, yelled "PONZI SCHEME!" and stormed out. "Most generalist venture capitalists do not believe in this [Peer-to-peer finance] sector," Stephens says." "Cryptocurrency mania fuels hype and fear at venture firms" (*Wired*, November 9, 2017)

I began writing this thesis in 2013, back when crowdfunding was new, cryptocurrencies were only used by fringe actors, and the field of finance was not yet feeling the extent of the threat that peer-to-peer innovations would pose to "business as usual" for them. After the 2008 financial crisis, the finance sector faced a dearth of trust,[1] and a number of actors, most of them entrepreneurs, had begun to offer peer-to-peer services—powered by digital information technologies (DITs)—that could offer services quickly, more efficiently, and more transparently than those mediated by established financial infrastructures.

These services tapped into individuals' expectation—likely driven by smartphones—to be able to do more of their everyday activities instantaneously and peer-to-peer. Crowdfunding, the subject of one of the papers in this thesis, offers individuals the chance to control their own investments, and offers firms the chance to appeal to their *actual* customers for funding, rather than once-removed investment professionals. Distributed ledger technologies and cryptocurrencies, the focus of three papers in this thesis, offer individuals an increasing number of possibilities—from currencies, to smart contracts, and more—that operate peer-to-peer.

Past technical advances based on non-digital infrastructures are well-documented: studies of electricity (Sine & David, 2003), telephones (Sawhney, 1992), and railroads (Jahanshahi, 1998) have examined the impact of new infrastructures on society. However, these infrastructures are not as dynamic, flexible or generative as digital infrastructures are theorised to be (Tilson, Sorensen, & Lyytinen, 2012). This means not only that old theory around the impact of infrastructural advances may need to be revisited, but that these peer-to-peer phenomena, and the infrastructures that enable them, provide rich areas for new theory development.

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[1] A product both of how individuals and organisations had behaved, as well as because financial services were untransparent, privileged elites, and had centralised organisations—making for easy intervention. See, for instance, Lewis, M. (2011). *The Big Short: Inside the Doomsday Machine*. WW Norton & Company.

Extensive advances in DIT, and the embeddedness and interdependencies that are unique to DITs have meant that the peer-to-peer possibilities are both more extensive, and more complex, than in earlier waves of technical advancement. Indeed, the modularity of digital infrastructures has been said to render them generative (Baldwin & Clark, 1997; Yoo, Boland, Lyytinen, & Majchrzak, 2012), such that they not only can be used in a range of intended and designed-in ways (Pipek & Wulf, 2009), but also innumerable unintended ways (Zittrain, 2006).

The motivation behind this thesis was partly empirical in nature; I was interested in what the digital meant for entrepreneurs, and how digital infrastructures—proffered by entrepreneurs as so revolutionary that they would upend financial infrastructures—affected their entrepreneurial process. This interest in the phenomenon led me to the theory that helped me made sense of these emerging infrastructural shifts.

Contribution and Theoretical Overview

While my initial interest was in the phenomenon of peer-to-peer finance, this thesis has become a way for me to understand, both theoretically and in practice, how digital infrastructure emergence occurs, and the role of a) digital entrepreneuring, defined as the process whereby new social and economic practices are produced and reproduced using digital artefacts, and b) digital infrastructures themselves, in this emergence. As such, it zooms in on how the interplay between digital infrastructures and digital entrepreneuring leads to new financial infrastructures emerging.

Digital infrastructure are more than DITs actively involved in business processes; they actually form the foundation for such activities (Star, 1999). Our understanding of how DITs come to be infrastructural, and the implications of how this occurs is still emerging. What is clear, however, is that the use of digital infrastructures means that non-digital processes and practices are not just being transferred to digital spaces. Rather, they are being fundamentally altered.

Consider the distinction between digitisation and digitalisation: while digitisation describes the technical process of making a formerly analogue process digital, digitalisation describes the "socio-technical process of applying digitizing techniques to broader social and institutional contexts that render digital technologies infrastructural" (Tilson, Lyytinen, & Sørensen, 2010: 749). Taking entrepreneurial processes and digitising them is a mere technical step; the resulting processes are substantially the same and the fact of digitisation merely changes the *medium*, not the process. In contrast, digitalisation of entrepreneurial processes entails changes in the processes themselves as they are irrevocably altered in response to the possibilities (and constraints) that digitalisation affords. The question is: how?

Despite the increased importance of the digital for businesses new and old, the rise in interest in entrepreneurship in general, and the competitiveness of firms that are digital-first (Tumbas, Seidel, Berente, & Brocke, 2015), the notion of "digital entrepreneurship" has only entered academic literature very recently. However, the tide is turning: there have been recent calls to take account of the role of the digital in studies of digital entrepreneurship (Nambisan, 2016), and an upcoming special issue in the *Information Systems Journal* carries the theme "Digital entrepreneurship", and *Computers in Human Behavior* recently had a call for papers on "Entrepreneurship and innovation in the digital era".

Thus far, entrepreneurship using digital "tools" has been treated as substantially the same as one or more other types of entrepreneurship, for instance as high tech entrepreneurship (e.g. Park, 2005), internet entrepreneurship (e.g. Drori, Honig, & Sheaffer, 2009; Serarols, 2008), or entrepreneurship using open innovation (e.g. Gruber & Henkel, 2006; Yetis-Larsson, Teigland, & Dovbysh, 2015). However, recent empirical and theoretical work on the importance of the digital—as constellations of "objects, sites, and bodies" that matter (Ashcraft, Kuhn, & Cooren, 2009; Leonardi, 2010)—highlights their importance in organising. The thread that links these works is the argument that digital artefacts are more than mere tools, but actually fundamentally alter organising processes and practices (Orlikowski & Scott, 2015; Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007). Accordingly, studies of phenomena and processes that involve digital artefacts should explicitly consider their importance, in order to better understand organising—and entrepreneuring—in the digital age.

At the same time, the pervasiveness of digital infrastructures is also being recognised in academic scholarship: a recent *MIS Quarterly* special issue on "Digital Innovation Management" included a number of papers that examined digital platforms and infrastructures (Nambisan, Lyytinen, Majchrzak, & Song, 2017).

In order to capture both digital artefacts' mediating and relational role, and the interplay between them and entrepreneurs, I have adopted a practice lens. This approach collapses levels of analysis and argues that "knowledge" encompasses those action and the potential for action (Whittington, 2006). I therefore examining entrepreneurship as a series of practices referred to as "entrepreneuring" (Johannisson, 2011), and argue further that digital entrepreneuring differs fundamentally from the garden variety of entrepreneuring because of the importance of digital artefacts in entrepreneurial activities.IS

This thesis makes the following contributions. First, it bridges a number of gaps between entrepreneurship and Information Systems (IS) scholarship, showing how IS methods and approaches can enrich entrepreneurship scholarship, especially through digital entrepreneuring. Second, it investigates empirically the importance of digital infrastructures in their own perpetuation, and in mediating

relational activities pursuant to organising and entrepreneurship. It finds that design and code significantly alter how organising occurs, and that certain outcomes can be designed-for. It finds that the technical and social embeddedness hitherto theorised affects entrepreneurial processes—and not just when Open Source communities are involved. Third, it demonstrates new organising processes in the areas of legitimacy building, consensus-building, and disagreement.

This research therefore covers topics that are of interest for contemporary IS and entrepreneurship scholars, through examinations of two phenomena, namely crowdfunding (and platforms), and the blockchain (and digital code), and digital entrepreneuring in general.

Thesis Structure

This thesis is comprised of six chapters: an introductory chapter (or "kappa"), and five papers, as summarised in Table 1. The introductory chapter not only includes summaries of the included papers, but also shows how the papers contribute to the overarching research goals described above.

Table 1: Papers in this thesis (incl. Introduction), their authors and research questions

Chapters	Authors	Research Question
1. Introductory Chapter	Ingram Bogusz, C.	N/A
2. Patterns of Self-Organising in the Bitcoin Online Community: Code Forking as Organising in Digital Infrastructure	Andersen, JV and Ingram Bogusz, C.	What is the role of code forking in digital infrastructures in the self-organisation of OS communities?
3. Taming digital flexibility: An embeddedness approach to entrepreneurial activity	Ingram Bogusz, C.	How can we understand the effect of embeddedness on the flexibility of entrepreneurship using digital infrastructures?
4. Platform use takes more than trust: Designed legitimacy on a crowdfunding platform	Ingram Bogusz, C.; Teigland, R; and Vaast, E.	How can a two-sided crowdfunding platform come to be seen as legitimate?
5. How infrastructures anchor open entrepreneurship: the case of Bitcoin and stigma	Ingram Bogusz, C. and Morisse, M.	How does ideology affect open entrepreneurs' responses to stigma?
6. Coding for collective action: the case of the digital economic social movement of Bitcoin	Ingram Bogusz, C., and Andersen, JV.	How does collective action emerge in the digital economic social movement of Bitcoin?

However, writing a PhD thesis is itself a "generative" process: the individual papers took on lives of their own as I wrote them (and as reviewers got their hands on them). I therefore invite the reader to see this PhD thesis as something that has

itself emerged over the past 4 years; the papers have complex interdependencies and have been written to stand on their own. They nevertheless contribute to the larger intellectual journey that I describe in this introductory chapter.

This introductory chapter is comprised of five overarching sections. The first of these discusses the roots of my interest in the digital, entrepreneuring, and the field of finance. It links this interest to the phenomena that this thesis explores, and their empirical importance, as well as my research approach, methods and underlying practice approach.

The second section positions this introductory chapter theoretically by examining the IS, entrepreneurship and organisation literatures I build upon.

The third section presents the contributions of the five papers contained in this thesis, both to the overarching research question, and to their individual research questions.

The fourth section discusses the theoretical and practical implications of this thesis.

I conclude, as one does, with a conclusion.

Background: (Infra)Structures and Change

The financial crisis of 2008 brought to the fore cracks in pre-crisis financial structures. The events that led to this—starting with defaults on mortgage-backed bonds in the US—read like a melodrama. In fact, a number of page-turners have been written about the events that led to the crisis. My favourite among these is *The Big Short* by journalist Michael Lewis:

> Back in the 1980s, the original stated purpose of the mortgage-backed bond had been to redistribute the risk associated with home mortgage lending. Home mortgage loans could find their way to the bond market investors willing to pay the most for them. The interest rate paid by the homeowner would thus fall. The goal of the innovation, in short, was to make the financial markets more efficient. Now, somehow, the same innovative spirit was being put to the opposite purpose: to hide the risk by complicating it. …it didn't require any sort of genius to see the fortune to be had from the laundering of triple-B-rated bonds into triple-A-rated bonds.

When these bonds eventually collapsed, the bankers earning multi-million dollar bonuses in financial centres across the globe came under scrutiny. The transactions they had been involved with were the very definition of moral hazard: they were incentivised to take risks with their clients' money, and made a commission for

doing so. What is worse, while one arm of some banks gambled, the other arm hedged: In the US, JP Morgan was fined 296.9 million USD and Goldman Sachs was fined 550 million USD for shorting on the crisis they had played a role in creating (SEC, 2017). Financial markets across the world reeled, stockmarkets crashed, and millions lost their savings, their jobs and their homes.

In the wake of the crisis, governments bailed out banks and insurance agencies with taxpayers' money in the US, UK, Germany, and others. For many, this added insult to injury; not only did bankers lose trillions through perverse incentives, they were being given *more* money by governments. In fact, as the contagion spread, the web of loans was depicted as more convoluted and nefarious, as Lewis describes in *Boomerang: Travels in the New Third World:*

> One view of the European debt crisis—the Greek street view—is that it is an elaborate attempt by the German government on behalf of its banks to get their money back without calling attention to what they are up to. The German government gives money to the European Union rescue fund so that it can give money to the Irish government so that the Irish government can give money to Irish banks, so the Irish banks can repay their loans to the German banks. "They are playing billiards," says [German Economist Henrik] Enderlein. "The easier way to do it would be to give German money to the German banks and let the Irish banks fail.

As though this were not enough, governments across the globe began courses of quantitative easing (QE), wherein they bought government securities in order to increase the money supply. Although I have never heard anyone complain about the effects of this on markets (by all accounts, QE has made markets buoyant), many free market enthusiasts argue that this meddling makes firms—and governments—fat and inefficient.

I began this thesis in 2013, when some of the dust had settled after the financial crisis. However, banks, governments and other elites (including the neo-liberal economists who failed to predict the crisis) had come to be viewed with suspicion:

> The first inkling of the wider political consequences was evident in the turn in public opinion against the banks, bankers and business leaders. For decades, they could do no wrong: they were feted as the role models of our age, the default troubleshooters of choice in education, health and seemingly everything else. Now, though, their star was in steep descent... The effect of the financial crisis was to undermine faith and trust in the competence of the governing elites. (*The Guardian*, 21 August 2016)

Two things resulted from these suspicions: first, a wave of reactionary political parties from both the far right and the far left.[2] Second, new financial services: some

[2] Given the chance to write a second thesis, I would not say no to writing about them, too.

positioned themselves, collectively, as social movements, while individuals among them were more modest in their entrepreneurial ambitions.

The financial infrastructures that existed when I began this thesis were just beginning to be affected by these new services. They promised to "democratise" structures seen as inefficient (Nakamoto, 2008a), dominated by elites (Hardt & Negri, 2011), and ultimately untrustworthy (Shiller, 2012). Critically, these services sought to do this by moving some—or all—of the existing financial structures from the hands of elites, whether by democratising investment through crowdfunding platforms, or by building distributed ledgers (or blockchains) to automate (among other things) transactions (and thus prevent intervention in the financial infrastructures of the future).

In essence, the goal of those championing these services was not to change the controlling elites, or even to change the social structures (including laws and the like) that gave rise to the financial crisis and subsequent interventions. No, they wanted to replace the underlying infrastructure, piece by piece.

New Financial Infrastructures Emerging

My interest was initially piqued by the role that entrepreneurs were playing in this process. While institutional theory points to the fact that changes to social institutions often emerge from the periphery (e.g. Wright & Zammuto, 2013), often through what is called "institutional entrepreneurship" (Aldrich & Fiol, 1994; Battilana, Leca, & Boxenbaum, 2009), these actors are hindered by everything from a lack of legitimacy (Suchman, 1995) to a lack of resources (Witt, 2004). However, these challenges are not what they once where: it has been argued that the digital age has lowered the barriers to entry for entrepreneurs (Serarols, 2008). Moreover, entrepreneurs operating using digital code, typically those offering digital products and services, benefit from sharing code (von Krogh, Spaeth, & Karim R Lakhani, 2003) and social networks that are specific to the digital realm (Yetis-Larsson et al., 2015). Why, then, should the whole digital process not look different when it comes to digital entrepreneuring pursuant to replacing existing financial infrastructures.

Infrastructures form the foundation not only for how the financial system operated, but also to how societies operate. This means not only that it would involve significant risks to try to replace them in one fell swoop (because of the risk of unintended consequences), but also that the web of interdependencies that they are part of makes this impossible. These infrastructures are maintained and perpetuated by multiple, distributed actors (Yoo, Henfridsson, & Lyytinen, 2010), and infrastructures are often nested in other infrastructures, making the outright

replacement of one infrastructure a slow, piecemeal process, and one that involves multiple actors.

I began by delving into digital entrepreneuring (Chapters 4 and 5). However, I soon realised that understanding how digital infrastructures affected digital entrepreneuring—and vice-versa—required a clearer understanding of the role of the code itself in affecting what could—and could not—be achieved with a digital infrastructure (Chapters 2 and 3). I also became intrigued by how digital entrepreneuring "writ large"; that is, digital entrepreneuring by a collective aiming to change financial infrastructures, looked like in practice (Chapter 6).

Having discussed the background to this thesis, including why it interested me and why it has emerged in the form it has, I turn now to discussing my research approach and empirical interest, before turning to the theoretical background to my thesis's contribution(s), and ultimately discussing these contributions.

Research Approach

When I started out this thesis, I was interested in how institutions came to be formed, perpetuated, and changed (e.g. DiMaggio & Powell, 1983; Meyer, 2006) by the digital. I quickly realised that the social changes I was observing were affected by—and themselves affected—the DITs involved. What is worth noting is that institutions and infrastructures share one vital trait; they are taken for granted up until the moment when they start to fail. At that point, both their presence and their machinations become apparent (Dacin, Goodstein, & Scott, 2002; Star, 1999).

As I was interested in how change came to occur (or not occur), it made sense to look at what was dominant and how it was being affected. What I quickly noticed, however, was that changes at the macro-level was hard to isolate from the multiple activities that perpetuated it, and those that changed it. While institutional entrepreneurship (e.g. Battilana et al., 2009; Hardy & Maguire, 2008) was a lens that closely mirrored the process I was studying, it lacked the enabling and constraining qualities that I was beginning to see in the technologies I was observing. Capturing both the material/digital and practices is uncommon in entrepreneurship literature (although see Smets, Morris, & Greenwood, 2012), and studies of entrepreneurship are uncommon in IS literatures—I therefore had to build on both literatures in order to make sense of what I was seeing.

I also faced with a number of methodological problems, not least how to approach the messy phenomena that I was seeing.

Ontology, Epistemology and Data Collection

First, what was the level of analysis that I was interested in? Being a novice researcher, this was one of the hardest to grapple with. In principle I was interested in the processes occurring (Langley, 1999), but the data that I was collecting could not capture the entire process, both as it was still emerging, and because of the relational nature of the digital artefacts involved.

In the early stages of this thesis I collected data through interviews with entrepreneurs; the level of analysis was therefore on the individual firm (see Chapter 5). However, as I observed (and was told about) the vital role that the decentralised technologies being used played in how they pursued their firm goals, I could not exclusively examine the individual or the firm.

Ultimately, my level of analysis became one that approximated the practice-level; that is, an approach that collapses the notion of levels of analysis entirely: into actions and action potentials. In this approach, practices are defined as "embodied, materially mediated arrays of human activity centrally organized around shared practical understandings[s]" (Schatzki, 2001). This allowed me to zoom in on both entrepreneuring and on digital infrastructures.

A practice approach avoids giving primacy to institutions (Suddaby, 2010), technology (Goh, Gao, & Agarwal, 2011), networks (Elfring & Hulsink, 2003) or human agency (Battilana et al., 2009; Levy & Scully, 2007). Instead, it treats all of these as intertwined in the perpetuation or creation of a practice, neither agency nor the artefact takes precedence.

Action or action potentials are therefore seen as emergent phenomena; they may perpetuate themselves, but in their repetition—and due to deliberate interventions—may also gradually change. In the context of the empirical investigation of strategy practices Rasche and Chia suggest that the social, "routinised behaviour of the body, the use of objects, the application of background tacit knowledge *in situ*, and the constitution of practitioners' identity through practices" (Rasche & Chia, 2009) are important areas of empirical investigation.

In this thesis, I treat digital entrepreneuring in digital infrastructures as an ongoing, creative organisation process that built upon shared understandings. These shared understandings, formerly local and measured on the individual and organisational level are informed by broader cultural frameworks, including overarching institutional logics (Jarzabkowski, 2004; Lounsbury & Crumley, 2007), amount to practices *writ large*.

Collapsing the level of analysis to take into account both human and non-human activities meant that I did not have to engage with questions around what the world looked like (my ontology), or what I could know about the world around

me (epistemology). Instead, it reduced my theorising to the level of activity: what was actually happening?

This had implications for how I answered a second question, namely, what kind of data would allow me to see these practices? There is a range of practice-based approaches to both data collection and theorising: from the "purist", which examine almost exclusively action as it occurs (through participant observation, mostly, e.g. Reckwitz, 2002; Smets, Morris, & Greenwood, 2012) to those capture as much of the practices as they can using combinations of other data, for instance by combining interviews with observations, or asking people in interviews to describe the actions they took (Yakhlef, 2010). These data collection methods seek to tease out the actions, or practices, that occurred, but some require that the researcher see them in person—while the more pragmatic argue that asking people to recall what had occurred is not only practical, but in many cases the only way to access useful data.

I tended to this pragmatic way of trying to capture the activities that occurred as a result of human and digital interaction. What this meant was that I collected interview data (e.g. in Chapters 4 and 5), but also made use of forum data insofar as it represented these activities as accurately as interviews (e.g. in Chapters 2, 4 and 6).

Having discussed my interest in post-financial crisis attempts to change underlying financial infrastructures, and how I studied them, I turn now to discussing the specific empirical cases that I found interesting. These empirical cases are discussed further in individual papers.

Empirical Phenomena

Entrepreneuring mediated by DITs is known to be both turbulent (Davidson & Vaast, 2010), and characterised by low barriers to entry (and exit) (MacInnes, Moneta, Caraballo, & Sarni, 2002). Distributed groups of individuals, notably in Open Source (OS) have a long history of sharing resources (e.g. code, knowledge) among themselves (Rentocchini & Rossi-lamastra, 2012) and newcomers bring with them new ideas, concepts and points of view, which enrich the community and open new ways of problem solving (von Krogh, Spaeth, & Lakhani, 2003b).

Indeed, organisations can now be built and sustained largely or solely in this digital substrate, leading to dynamism and rendering geographical and technological boundaries irrelevant or a minor inconvenience (Dougherty & Dunne, 2012; Hewitt & Forte, 2006). These areas of previous research suggest that both entrepreneuring itself, and the organising that happens around entrepreneuring, is fundamentally being altered by digital mediation.

Choice of Phenomena and Cases

The two phenomena which this thesis zooms in on are crowdfunding ("crowds") and cryptocurrencies ("coins") that make use of distributed ledger, or blockchain, technologies. The latter are supported by OS communities ("communities"), however, the ahierarchical, distributed nature of both phenomena means that extant research on OS communities may help us understand how and why they operate the way(s) that they do.

Choosing these phenomena to study was emergent; that is, I followed the breadcrumbs around where the most significant digital changes affecting the financial system were occurring, reasoning that these presented the most interesting extreme cases for understanding changes in digital infrastructures through entrepreneuring (Siggelkow, 2007). In the case of individual firms, given the nascence of the phenomena I was studying when I did, I was limited by the inability to identify actors in the digital world (itself a phenomenon deserving of study, see Chapter 4). However, the actors—and other data sources—that I made use of were very transparent, and where relevant I used snowballing processes to find data to support (or contradict) research findings.

Here, I discuss in brief prior research around crowdfunding ("Crowds"), distributed ledger technologies ("Coins"), and OS communities ("Communities"), as they relate to this thesis.

Crowds

The phenomenon of crowdfunding has drawn immense interest in recent years, drawing attention from policy makers looking to encourage entrepreneurship (Stemler, 2013) to economic geographers looking at its distribution (Agrawal, Catalini, & Goldfarb, 2015) to entrepreneurship scholars interested in predictors of its success (Mollick, 2013), its distribution of resources (Mollick & Robb, 2016) and its uses in niche financing, for instance in science (Wheat, Wang, Byrnes, & Ranganathan, 2013), journalism (Jian & Usher, 2014), music (Galuszka & Bystrov, 2014) and film production (Braet, Spek, & Pauwels, 2013). Mollick and Nanda define it as:

> a novel method for funding a variety of new ventures, allowing individual founders of for-profit, cultural, or social projects to request funding from many individuals, often in return for future products or equity … crowdfunding allows the crowd to directly fund artistic and for- profit ventures, a process previously reserved to expert judges, from panellists in grant-making bodies to venture capitalists. (2015: 1538).

Most research into crowdfunding has looked at how and distributed individuals fund entrepreneurial ventures online. Motivation has been a particular area of interest (Belleflamme, Lambert, & Schwienbacher, 2014; Burtch, Ghose, & Wattal, 2013), as has the crowd's ability to screen projects (Mollick & Nanda, 2015; Ward & Ramachandran, 2010).

Recent findings suggest that not all crowdfunders are the same, which is unsurprising considering there are at least four well-documented forms of crowdfunding. These include donation-based crowdfunding, where money is given for philanthropic or altruistic reasons (Özdemir, Faris, & Srivastava, 2015); reward-based crowdfunding in which substantial or symbolic rewards are incentives for investment (Nucciarelli et al., 2017); equity-based crowdfunding in which entrepreneurs obtain an equity stake in a crowdfunded venture in exchange for investment (Stemler, 2013); and lastly debt-based crowdfunding, also known as peer-to-peer or microlending, where an investor earns interest on his or her online investment (Allison, Davis, Short, & Webb, 2015).

The most valuable area of crowdfunding is debt-based crowdfunding where the possibility of receiving interest payments, especially in the rich world where interest rates are near-zero, is drawing participation (Younkin & Kashkooli, 2016). Among reward-based crowdfunding, rewards have been identified as a large motivator for crowdfunding investment (Younkin & Kashkooli, 2016), as has fan support or "fanvestment" (Galuszka & Bystrov, 2014).

Among debt- and equity-based crowdfunding, extant literatures have treated the crowd as investor-like (e.g. Agrawal et al., 2015; Belleflamme et al., 2014; Bruton, Khavul, Siegel, & Wright, 2015; Lehner, 2013). Drawing on professional investment literatures, Mollick and Robb found that reward-based investors on Kickstarter were driven by similar motives to professional VC investors when it came to investing in crowdfunding projects: they found that 91 percent of investors looked for a viable prototype, and that 81 percent of investors saw past project success as an indicator of future success (Mollick & Robb, 2016). These sentiments are echoed in other studies (e.g. Bruton et al., 2015; Mollick & Nanda, 2015).

Consequently, entrepreneurs using crowdfunding are advised to signal these competencies, make use of traditional equity investment terms and credible narratives in order to signal legitimacy (Frydrych, Bock, Kinder, & Koeck, 2014). Social capital and social networks have been identified as key drivers of most of these forms of crowdfunding. Local social networks and close geographic proximity have, for instance, been key in driving early-stage investment in at least one equity platform (Agrawal et al., 2015), suggesting that local reputation and trust is an important driver of early-stage investment.

To my knowledge, researchers examining crowdfunding have not looked at how the crowd organises itself. On the contrary, most seem to assume that the crowd is comprised of a large number of individuals who make decisions independently of one another. Indeed, investors rely on collective signals such as previous projects (Mollick & Robb, 2016), on online social capital (Colombo, Franzoni, & Rossi-Lamastra, 2015), cascades (Koning & Model, 2014), and that herding behaviour has been seen among debt-based crowdfunders (Lee & Lee, 2012).

When it comes to the crowdfunding platforms, research is much thinner. the question of why an entrepreneur would be attracted to such a platform is often treated as self-evident: the result of a dearth of funding, especially in developed nations post-recession (e.g. Belleflamme et al., 2014; Mollick, 2013). However, researchers suggest that design considerations may influence crowdfunding platform choice and use (Kuo & Gerber, 2012), and that the platform's own ability to build—and maintain—relationships may affect the likelihood of it being used (Beier & Wagner, 2014).

Coins

Interest in Bitcoins, cryptocurrencies and the distributed ledger technologies has increased exponentially since this thesis began. However, most of the research in this area is technical in nature. However, IS and management journals have called for papers researching this phenomenon recently: The *Journal of the Association for Information Systems* (JAIS) has a Special Issue Call for Papers on the "Opportunities and Challenges of Blockchain Technology" in 2018, and other journals—from *Computer* to *Electronic Markets*—have recently called for papers into the broader phenomenon of FinTech, including distributed ledger technologies.

Given the low level of knowledge about distributed ledger technologies today, Chapter 2 in this thesis explains how they work in some detail:

> While [Distributed ledger technologies were once] largely known for [their] role in automating transactions made using the cryptocurrency Bitcoin, [they are] today being developed for other purposes, including the transfer of other kinds of assets, and for recordkeeping (Morisse & Ingram, 2016). The original Blockchain, however, was not built to support these kinds of individual or organisational aims. Although its founder(s), pseudonymous Satoshi Nakamoto, discussed in a white paper how it might revolutionise the finance industry, it was not developed by an organisation with the intention of changing the industry, merely of showing how this might be done (Nakamoto, 2008a). Moreover, its founder(s) withdrew from the development of the project at a very early stage—leaving a new community to form around it. As the infrastructure pre-dated the community, it drove how the community developed and was

> organised. Indeed, unlike infrastructures that have been previously studied, the community could not use the infrastructure for anything other than its original sets of functions without changing it considerably, and these changes were constrained by elements of the infrastructure's source code.
>
> The maintenance and development of the Blockchain has partly been done by a community of developers,[3] who are mostly distributed across the globe. These developers in many ways resemble an OS community. However, while these developers are an organised community, maintenance of the infrastructure does not rely solely on development of the code. Instead, the infrastructure relies on the participation of so-called "miners" to verify and encrypt transactions as they occur, and then inscribe them onto a blockchain ledger, as well as the users who conduct transactions using the infrastructure. The source code incentivises one of a number of computers (or 'miners') to solve a cryptographic puzzle, and in so doing encrypting a given transaction into a block. Once a block of size 1mb is reached, the system initiates a new block, and the blocks are in a chain, as records of all past transactions, in what is known as a blockchain. Here, we will refer to the technology as the Blockchain, and this digital ledger as a blockchain. Thus, the maintenance and development of the Blockchain relies on a number of distributed actors for multiple purposes: first, to maintain and de-bug the underlying source code, second, to maintain the blockchain and the functioning of the Blockchain through mining, and third for individual users to execute transactions using the infrastructure.
>
> The underlying source code, however, puts limits on what these distributed actors can do. For instance, the entry of a new transaction onto the blockchain by a miner is communicated to the other miners in the network in order to for them to verify that it is legitimate and consistent with previous entries (and doesn't come from a fake account, for instance). In this way, the blockchain is both kept up to date and its contents are verified and stored by other miners. The software is designed so that transactions can only be added onto the blockchain after verification by the rest of the actors, and cannot be removed once entered without changing the entire blockchain.[4] The blockchain therefore becomes more-or-less unassailable. This position is secured by virtue of a part of the source code in the Blockchain protocol, which says that the version of the software, which includes the blockchain, held by the majority of miners is the "real" Blockchain (Nakamoto, 2008; Taylor, 2013). (Earlier version of Chapter 2)

Studies of Bitcoin and distributed ledger technologies have looked at the economics of Bitcoin as a currency (e.g. Yelowitz & Wilson, 2015; Yermack, 2013), and mining Bitcoins (e.g. Eyal & Sirer, 2014; Malone & O'Dwyer, 2014). However, recent studies have also looked at the social dynamics behind the community, for instance how they are a sociomaterial enactment of the will of the community be-

[3] Some of whom are linked to an organisation known as the Bitcoin Foundation

[4] Although there is some discussion around how much control is required to retrospectively change the blockchain, see e.g. Eyal, I. and Sirer, E.G., 2014, March. Majority is not enough: Bitcoin mining is vulnerable. In *International Conference on Financial Cryptography and Data Security* (pp. 436-454). Springer Berlin Heidelberg.

hind them (Karlstrøm, 2014), and the libertarian political belief system that surrounds Bitcoin (Dallyn, 2017).

The chapters in this thesis, as well as other ongoing work, contribute to the growing social and managerial understanding of distributed ledger technologies and the cryptocurrencies (and tokens) that they use.

Communities

Both crowdfunding and distributed ledger infrastructures might equally be pioneered by established or incumbent organisations. While this has begun to happen since I began this thesis, when I collected my data it was almost exclusively the province of entrepreneurs, reliant on distributed groups in varying ways. What is worth noting, however, is that established organisations commercialising these technologies also have to contend with distributed individuals and groups—and therefore the findings of this thesis provide insights for them too.

One well-established organisational form that supports the creation of new digital infrastructures (and other code-based projects) is the OS community. Although these communities are not directly part of the phenomenon of crowdfunding, they are incredibly important for the creation, maintenance and evolution of blockchain-based infrastructures.

Members of these communities come together to solve shared problems, or what have been called "intellectual itches" (Raymond, 1999). These communities operate despite their members being far apart, and the projects that they work on are almost exclusively code-based in nature (Haefliger, Von Krogh, & Spaeth, 2008), and open source (von Krogh & Spaeth, 2007). This OS code can be, and is, readily shared and re-used (Nyman & Lindman, 2013). Sharing both the underlying code and potential changes to the code means that both bugs within the code, and threats to the infrastructure (for instance from hacking) are dealt with collectively by members of the community. Changes to the underlying code are commonplace, and expected (Fang & Neufeld, 2009), and often there is consensus as to what should be changed or fine-tuned, and why. Such changes to the code are discussed among developers and contributors and, as such, visible in, for instance, online forums (Phang, Kankanhalli, & Huang, 2014), although it may take negotiation to come to an agreement and some members of the community may be more active than others (Phang, Kankanhalli, & Tan, 2015).

These projects are run against the backdrop of an OS licence. Although there are many kinds of OS licence, they typically allow, at a minimum, the free re-use of code covered by that licence. As a result, splits from the original OS project cannot be prohibited, although are typically discouraged (Nyman, 2015).

These communities not only communicate almost entirely online, through forums and the like (Garg, Smith, & Telang, 2011; Johnson, Faraj, & Kudaravalli, 2014), they are also typically without hierarchical authority structures (Lee & Cole, 2003). Indeed, the rejection of formal hierarchy is often so strong that legal or normative sanctions have been seen to backfire on the enforcer (O'Mahony, 2003). Instead, collaboration is prioritised above all else; this involves radically different sets of competencies and skills, shared across distributed settings (Boudreau & Lakhani, 2009; Lakhani & Panetta, 2007). For instance, ideology, and with it social capital, encourage the sharing of knowledge and resources (Ljungberg, 2000). They have also been obliged to make changes in their organisational structures, as digital components replace or are combined with existing products and services (Baldwin & Clark, 2000; Langlois, 2002).

Among OS communities, sharing knowledge can signal competence and skill, which has reputational effects (Lerner & Tirole, 2005). Given the lack of formal hierarchy, informal systems of knowledge sharing have evolved (Davison, Ou, & Martinsons, 2013; Sowe, Stamelos, & Angelis, 2008); these involve mailing lists, forums and digital repositories (Lakhani & Von Hippel, 2003; von Krogh et al., 2003a). Knowledge shared online becomes a public good. That is, people cannot be excluded from using it and use by one person does not prevent it being used by others (Baldwin & Clark, 2006).

Control of the code—and therefore elements of the organisation—which in an older paradigm would be the domain of top management, are now distributed to a heterogeneous network (Hardy & Maguire, 2008; Leca & Naccache, 2006). Consequently, digitalisation, to varying degrees, supplements and sometimes even replaces hierarchical command and control structures (Dhanarag & Parkhe, 2006).

The vast architectural as well as contextual knowledge needed to develop and maintain OS projects, including those that might be considered digital infrastructures, means that the range of competences necessary for successful institutional change to occur far exceeds the capabilities of a single actor (Yoo, Lyytinen, & Boland Jr., 2008). However, studies of OS communities provide some insight into how management and evolution, at least at the social level, might occur in digital entrepreneuring in digital infrastructures.

In entrepreneuring reliant on an OS community (or what is called "open entrepreneurship", Yetis-Larsson et al., 2015), knowledge, a strategically important resource (Grant & Baden-Fuller, 1995; Gupta & Govindarajan, 2000), is transferred from the collective to the individual firm to enable entrepreneurship. Among established firms, such knowledge is seen as crucial to competitive advantage and business survival (Lippman & Rumelt, 1982). Yetis-Larsson et al. (2015) found that participation in the OS community was necessary not only to obtain information, but also to exert influence in the community. Community

members may also offer to beta test an entrepreneur's service (Schmidt & Porter, 2001), give user-to-user assistance (Lakhani & Von Hippel, 2003), and leadership in the community could allow the entrepreneur to influence its social and technical development (O'Mahony & Ferraro, 2007).

Thus, reliance on these DITs opens up new organisational possibilities, not least when OS communities are involved. However, actors' social possibilities are also constrained by them. This characteristic of technology is well-documented in IS (Majchrzak & Markus, 2012), and means that associated organising processes are by their nature limited. In this sense, we could say that the vista opened up by the introduction of digital technologies, including among these financial infrastructures is, to a large extent, also constrained and confined within structures that are built by coders, as actors, themselves (Garud & Karnøe, 2003).

Having discussed the empirical phenomena that inspired, and are the subject of, this thesis, I turn now to discussing the overarching theoretical context.

Theoretical Context

> [Infrastructure] becomes visible upon breakdown. The normally visible quality of working infrastructure becomes visible when it breaks: the server is down, the bridge washes out, there is a power blackout. Even when there are back-up mechanisms or procedures, their existence further highlights the now-visible infrastructure. (Star, 1999: 382)

The Importance of Digital Infrastructures

This thesis's main area of interest is in the formation and emergence of digital infrastructures, especially through digital entrepreneuring. Digital infrastructures are comprised of two things: one or more digital artefacts, and a constellation of social activities that render those artefacts infrastructural (Star, 1999). Here, I discuss how and why artefacts are interesting, before moving on to how and why artefacts contribute to digital infrastructures. I then turn to discussing their limitations and possibilities, before reviewing extant approaches to studying entrepreneurship—and thus outlining the foundations for digital entrepreneuring as a concept.

Digital Artefacts

Digital artefacts are not just technological elements designed by software architects (McGarty, 1992), but rather are comprised of both social and technological aspects (Ciborra, 2000; Star & Ruhleder, 1996) or, to use the words of Sorensen and Gibson as "the ultimate convergence of the social and the technical" (2004: 191).

These units of technological and social interaction have relatively clear boundaries, and include platforms or modules, both built upon other structures (Yoo et al., 2010). Moreover, their maintenance and reproduction is locally controlled (Monteiro, Pollock, Hanseth, & Williams, 2013). However, their design, implementation and interactions may not occur in a single place or space (Pollock & Williams, 2010).

The idea that digital artefacts improve how a venture is managed is one that has stood the test of time (Melville, Kraemer, & Gurbaxani, 2004). However, the *how* of organising given the increased importance and pervasiveness of IT artefacts is incredible complex (Zammuto et al., 2007). This is because artefacts are increasingly likely to be part of interconnected systems, rather than stand-alone tools (Tilson et al., 2010). Moreover, these artefacts are either introduced as, or give rise to, social systems (Avgerou & Li, 2013), and therefore cannot be divorced from the social systems in which they operate, and which they perpetuate. In the same vein, the pervasiveness of these artefacts in social systems, including organisations, means that it is increasingly difficult, if not impossible, to separate the digital artefact from the social system with which it interacts (Orlikowski & Iacono, 2001).

Under conditions where multiple artefacts, whether platforms or modules, become foundational, we say that they become infrastructural.

Digital Infrastructures

Digital infrastructures are comprised of multiple artefacts and have a distinctly temporal character insofar as their implementation supports other artefacts, both those that are anticipated and those that are not, over time (Monteiro et al., 2013). These foundational systems, which rely on social practices for their actualisation while simultaneously enabling other social practices, have come to be known as digital infrastructures (Star, 1999; Tilson et al., 2010). As temporal systems, they are a product of a move away from stand-alone digital systems that support information management, to systems that are vastly inter-connected and inter-reliant, and support interaction (Braa, Hanseth, Heywood, Woinshet, & Shaw, 2007).

The main differences between digital artefacts and digital infrastructure are summarised in Table 2.

Table 2: Comparison of Artefacts and Infrastructures

	Artefact	**Infrastructure**
Composition	Both social and technical elements	
Boundaries	Clear(er) boundaries	Unclear boundaries
Control	Local control	Distributed control and maintenance
Connectivity	Single objects, includes modules and platforms	Multiple, interconnected artefacts
Visibility	Visible	Transparent
Temporality	Could be short- or long-term	Necessarily long-term
Dependencies	Dependent on infrastructures	Depended upon by artefacts, interdependent on other infrastructures. Said to be "taken for granted".

Star points out that what renders something infrastructural is a product of the context in which it is embedded:

> …within a given cultural context, the cook considers the water system as working infrastructure integral to making dinner. For the city planner or the plumber, it is a variable in a complex planning process or a target for repair. (1999: 380)

As such, digital infrastructures are part of human organising, and include both human work practices and the technological developments which both enable and constrain these practices.

Both platforms and other modules can then be built upon infrastructure. Platforms, here, are defined as an extensible codebase that establishes software system that provides core functions, upon which modules that can be added or subtracted to add functionality. The combination of the platform and the modules is referred to as the platform ecosystem (Cusumano & Gawer, 2002; Tiwana, Konsynski, & Bush, 2010). A platform provides infrastructure for heterogeneous users to connect to one another (Rochet & Tirole, 2003) and, in so doing, lowers the barriers to entry for those wishing to obtain resources or communicate (Eaton, Elaluf-Calderwood, Sørensen, & Yoo, 2015).

Star (1999) highlights a number of social characteristics of infrastructure that are important to highlight here.

First, infrastructures are "*taken for granted*", such that they only become visible when they break down or start to come apart. It was the appearance of this breakdown that first prompted my interest in digital infrastructures.

This breakdown is important, because, **second,** when there is a break then the usual mechanisms of *learning* and *practice* that reinforce infrastructural status are eroded. Infrastructures represent shared understandings about organisational arrangements; their infrastructural nature may not be apparent to those outside a

context, but it can be learned as one becomes more familiar with a context (Bowker & Star, 2000).

Third, infrastructure is *embedded* in other structures, social arrangements and technologies. This embeddedness (discussed in detail in Chapter 3) means that people working in or with an infrastructure do not always notice the individual elements that comprise the infrastructure, only that they are in it.

Fourth, infrastructure is *transparent;* it does not have to be re-invented or re-assembled for each task that it is used to support. Subsequent research has also called infrastructure *flexible* (Hanseth & Bygstad, 2015), referring to the same potential to use the infrastructure for multiple, including unintended, purposes.

Fifth, infrastructure has *scope*: that is, it has "reach beyond a single event or one-site practice" (Star, 1999: 391). Thus, infrastructure may be infrastructural in multiple contexts; for instance both in finance or in government, in the case of financial infrastructures. It may also be infrastructural in one context, and not in another, as in the case of the water system above.

Finally, and significantly for this study, breakdowns can only be fixed in modular increments. This *modularity* has been of interest for digital infrastructures scholars (Henfridsson, Mathiassen, & Svahn, 2014; Tiwana et al., 2010), and this technical characteristic is key to the evolution of infrastructures.

While modularity and scope have meant that digital infrastructures are typically lauded for their high levels of flexibility and generativity (Yoo et al., 2012), both their architecture and relational character means that there are limitations to what can be done with them.

Flexibility and Limitations

Prior research into digital infrastructures, has focused on stand-alone platforms and infrastructures which are easily controlled by a single firm (e.g. Beaulieu & Sarker, 2013; Eaton et al., 2015; Mollick, 2013; Tilson et al., 2010; Zvilichovsky, Inbar, & Barzilay, 2013). However, digital infrastructures of the kind that this thesis explores cannot be controlled by a single actor, whether because the amount of knowledge needed to maintain and develop the infrastructure is more vast than a single organisation can reasonably hope to harness (Yoo et al., 2010) or because distributed control makes the infrastructure more democratic (e.g. Hippel & Krogh, 2003; Mollick & Robb, 2016), and thus both more stable and more trustworthy than centralised infrastructures.

Indeed, infrastructures are more dynamic than stand-alone cases would suggest (Katz & Shapiro, 1994), meaning that extant empirical research has limited usefulness when it comes to understanding digital infrastructures controlled and pio-

neered by distributed groups, especially insofar as they may be challengers to the *status quo* (Eaton et al., 2015; Tiwana et al., 2010).

The flexibility of digital infrastructures has been widely heralded (e.g. Tilson et al., 2010; Yoo et al., 2012); the addition of platforms or modules to an infrastructure, or what is called modularity, means not only that new technical affordances can be added to digital infrastructures, but also that new social meaning can be attributed to existing and future modules. These two modes of expansion have given rise to a number of studies showing how new functionality—and meaning—can evolve in digital infrastructures. Chapter 2 in this thesis discusses these modes of evolution in more detail, but a summary of them is included in Table 3.

Table 3: Evolution of digital infrastructures (from Chapter 2)

Method	Description	Theoretical foundation	Example references
Adaptation	Distributed actors adapt to their environment through changes in tasks, technology and relations	Complexity theory	Hanseth & Lyytinen (2010) Nan (2011)
Inscription	Existing organisational practices are inscribed in technological artefacts	Actor Network Theory	Aanestad & Jensen (2011) Eaton et al. (2015) Yoo et al. (2005)
Interaction	Interactions in a community of practice resulting in new socio-technical relations	Collective learning and communities-of-practice	Fang & Neufeld (2009) Pipek & Wulf (2009)
Choice	Choice of infrastructure governance and organising as a result of informed management decision	Strategic choice theory	Beckert (1999) Broadbent & Weill (1997) Child (1997)

The innate flexibility and generativity of digital infrastructures not only leads to positive evolutions; it also may lead to unintended consequences (Zittrain, 2006). Indeed, it has been suggested that some digital infrastructures, notably those that are automated or use algorithms and machine learning (Beane & Orlikowski, 2015), are inscrutable—that is, it is not possible to see how the outcomes that evolve came to evolve. For this reason, it is important to conceptualise how digital infrastructures might be controlled, or their flexibility curtailed.

Tiwana et al. (2010) suggest that the governance of a platform, beyond market-driven resource allocation, should be of interest for researchers. In particular, they highlight a) decision rights, b) control, and c) proprietary versus shared ownership as key areas for future study. They argue that these elements of control over platforms (and, by implication, infrastructures) impact on the evolution and develop-

ment of the infrastructure by limiting which modules can be built onto the platform, how they express themselves when on the platform and who benefits from their presence on the platform. Control may relate to output control, wherein the platform owner specifies the criteria by which modules' outputs are evaluated, process control over the development of modules and clan control, or encouraging shared beliefs and norms as a way to control the development of the modules and thus the platform ecosystem (Tiwana et al., 2010).

Extant studies in this areas have focused on the architectural, or technical characteristics of infrastructures to do this (e.g. Eaton et al., 2015; Hanseth & Monteiro, 1997). I discuss these constraints further in Chapter 3, and have summarised extant architecture-focussed mechanisms for digital infrastructure control in Table 4.

Table 4: Existing conceptualisations of the constraints on digital infrastructures (from Chapter 3)

Limits to infrastructure flexibility	Definition of infrastructure control	Theoretical foundation(s)	Example references
Control points	The designing-in of nodes within the infrastructure itself that can be directly controlled	Design thinking, complexity theory	Broadbent & Weill 1997; Broadbent et al. 1999; Tilson et al. 2010; DeNardis 2012
Boundary resources (and objects)	The designing-in of modular elements that can be directly controlled, allowing for indirect control over the infrastructure	Innovation networks; boundary objects perspective	Ghazawneh & Henfridsson 2013; Eaton et al. 2015
Convergence	The process whereby infrastructures adopt similar standards, allowing for limited control	Process theory, phenomenology	Hanseth 2000; Herzhoff 2009; Herzhoff et al. 2010

In summary, due to their integration in social and work processes, infrastructures are difficult to draw boundaries around. Instead, they are at their most visible when they break down; the rest of the time they are considered so foundational that users take them for granted (Star & Ruhleder, 1996). However, their presence nevertheless forms the basis for not only social interactions, but also economic interactions.

Having discussed what digital infrastructures and the artefacts that comprise them are, and how they operate, I turn now to discussing their importance when it comes to economic activities, and entrepreneurship in particular.

Economic Activities and Digital Infrastructures

Like other social activities, entrepreneurship has been fundamentally altered by the use of digital infrastructures: the internet, common code bases, reusable code and common platforms like Facebook, Google, SAP and Kickstarter permeate the very nature of entrepreneurship as we think about it. The presence of these digital infrastructures has been said to lower barriers to entry (Lin & Huang, 2008), simplify internationalisation (Greenstein, Lerner, & Stern, 2013) and support new kinds of business models (Kuk & Janssen, 2013). This is both because the use of digital infrastructures themselves allow for hitherto unforeseen levels of flexibility as they build upon pre-existing networks of interaction (Hanseth & Monteiro, 1997) and common code bases (Yoo et al., 2010), and because digital data are have unique properties not found in physical infrastructures (Kallinikos, Aaltonen, & Marton, 2010). In essence, digital infrastructures' generativity has generated a great many entrepreneurs and entrepreneurial ventures—some more successful than others.

At the same time, however, these infrastructures may have limitations owing to the fact that elements are introduced piecemeal, often at different times and for different purposes (Ciborra, 2000). Moreover, there are dependencies built into digital infrastructures that limit how the infrastructure can change and evolve. Indeed, the fact that digital infrastructures are maintained in a distributed manner and require vast repositories of knowledge and skill to maintain and develop (Yoo et al., 2012) means that changes to these infrastructures are slow to emerge.

Building artefacts that rely on these infrastructures—for instance, new firms—is therefore relatively simple. However, the effects that these artefacts will have on the underlying infrastructure is typically unclear. Typically, these effects are too small to be significant. However, adoption of some artefacts by a critical mass could fundamentally change the underlying infrastructure. Consider, for instance, the adoption of digital banking by individuals. While the presence of online banking itself does not change the financial infrastructure upon which it depends, as more individuals use the mobile banking artefact, other artefacts are built that rely on it, thus making mobile banking a more foundational part of a financial infrastructure.

Studying Digital Infrastructures

There has been a broad move towards theorising in organisation research that takes explicit account of both material objects (Leonardi & Barley, 2008; Zammuto et al., 2007), and ones with digital materiality (Beane & Orlikowski, 2015; Yoo et al., 2012). Advocates of this "material turn" argue that studies have typically either ignored technology entirely, treated it as an emergent tool defined by an actor's

agency, or treated it as deterministic (Orlikowski, 1992; Orlikowski & Robey, 1991). In response to this, I propose to examine the infrastructural role that digital artefacts play in entrepreneurship, through what I call "digital entrepreneuring", grounded in a practice-based approach to understanding entrepreneurial processes (Johannisson, 2011). This approach answers calls from both the organisation literatures (Leonardi, 2013; Orlikowski & Robey, 1991) and the digital infrastructures literatures (Henfridsson & Bygstad, 2013) for us to interrogate the importance of digital artefacts in their own use and perpetuation, and provides a lens through which to see the relational infrastructures that emerge.

Understanding how infrastructures and artefacts enable, support and constrain entrepreneurship, and how they do this in ways unique to entrepreneuring in the digital realm, requires looking not just at the effects of digitalisation on entrepreneurship at the level of antecedents and consequences (e.g. Drori et al., 2009; Matlay, 2004; Serarols, 2008), but rather engaging with how processes associated with entrepreneurship have been fundamentally altered by the presence of digital artefacts and infrastructures (Davidson & Vaast, 2010). Indeed, digital artefacts are so central to the processes involved in digital entrepreneurship that entrepreneuring that relies upon them is a whole new category of entrepreneuring entirely, namely "digital entrepreneuring".

In studying these emergent changes to financial infrastructures, I am mindful of the warnings of those who have come before me. In particular, the tendency to examine both artefacts and infrastructures has introduced what Karasti et al. (2010, p. 407) call a bias introduced studying 'short-term temporal aspects' of information technologies. Similarly, Kallinikos (2004) has cautioned against the study of information artefacts predominately (or only) at the place where the user encounters them.

In order to study these emergent infrastructural changes, I have adopted approaches and methods that, I hope, will limit my exposure to these risks. First among these, I have adopted a practice-based approach to research and theorising that takes into account both users of artefacts and the artefacts themselves. Second, some of the studies in this thesis are short-term in nature (e.g. Chapters 4 and 5), while others are longitudinal (e.g. Chapters 2 and 6).

Digital Infrastructures and Entrepreneuring

In the papers that comprise this thesis, entrepreneurs sought to change the entire financial system in which they operated by changing—to a greater or lesser extent—the underlying infrastructure. Crowdfunding entrepreneurs sought to change a tiny corner of the financial system, namely entrepreneurial finance, while

Bitcoin/Blockchain entrepreneurs sought to fundamentally alter the infrastructure in areas ranging from payments, to cash management, to investment, and even as far as whether or not credit should be issued.

Thus far, evolution and emergence in digital infrastructures have been studied through the lens of digital innovation (e.g. Eaton et al., 2015; Henfridsson & Bygstad, 2013). While digital innovation and digital entrepreneurship cover some common ground, in this section I distinguish the two, and offer some reasons for why I opted to study the emergence of new financial infrastructures through the lens of entrepreneurship, and "entrepreneuring" in particular.

Digital Innovation

Digital innovation is an alternate lens through which to view the infrastructural changes that I have described thus far. It has been defined as "the use of digital technology during the process of innovating. Digital innovation can also be used to describe, fully or partly, the outcome of innovation" (Nambisan et al., 2017: 223). As an emergent body of literature itself, the goal of studies of digital innovation has been to "incorporate the variability, materiality, emergence, and richness of the socio-technical phenomenon called digital innovation" (Nambisan et al., 2017: 224).

It is characterised by innovation, or the creation of new products, materials, new processes, new services, and new organizational forms (Ettlie & Reza, 1992), using digital artefacts. Although the term "digital innovation" is relatively new, it has been implicitly being studied in areas such as distributed innovation (e.g. Lakhani & Panetta, 2007), open innovation (Chesbrough, 2003; Hippel & Krogh, 2003), and network-centric innovation (Nambisan & Sawhney, 2011).

Innovations are typically adopted by organisations hoping to generate novel or unique solutions to internal problems (Grover, Purvis, & Segars, 2007). Such innovations typically take the form of products, technologies or programmes that are new to the adopting organisation (Zaltman, Duncan, & Holbek, 1973). These innovations may be radical in nature, in that they result in significant changes to the organisation's behaviours (Lyytinen & Rose, 2004; Zaltman et al., 1973), or more incremental in their scope in that they change some behaviours, often through improving processes rather than introducing wholly new products or services (Benner & Tushman, 2002).

Further, innovation stems from increases in knowledge (Carlile 2002), and the movements of knowledge across boundaries, whether through networks (Boland, Lyytinen, & Yoo, 2007) or formal processes (Benner & Tushman, 2002).

Innovation itself has been plagued by a lack of consensus on what the processes involved are, and where the boundaries lie (for a deeper discussion, see Baregheh, Rowley, & Sambrook, 2009). Digital innovation has not yet been affect-

ed by this lack of clarity: the fact that it is an emerging body of literature has meant that its early users have defined it very inclusively. However, in a recent overview of the promise of digital innovation, Nambisan et al. (2017) suggest specifically that digital innovation is problem-solving oriented, and thus that it is likely to include "problem–solution pairs". In other words, studies of digital innovation are directed towards the solution of certain problems.

In contrast, entrepreneurship is value-creation oriented, with problem-solving as a means to that end (Davidsson & Wiklund, 2001). Thus, although innovation might come up with a process/product/service, it is not always the innovator that commercialises the innovation. Consequently, innovators and entrepreneurs face different challenges. Take, for instance, Bitcoin. One of the studies of the technology in this thesis looks specifically at Bitcoin entrepreneurs (Chapter 4). These individuals (and their firms) make use of an existing innovation, and build firms upon it—with the intention to generate profit. They build these firms with the intention to profit further when (or if) financial infrastructures change.

Both innovation and entrepreneurship are uncertain processes, but the goals of the two differ subtly: innovators set out to solve specific problems, while entrepreneurs set out to create value through solving a problem. What results is what has been called "creative destruction" (Schumpeter, 1934).

Moreover, while digital innovation can equally occur in incumbent firms (Svahn, Mathiassen, & Lindgren, 2017), digital entrepreneuring cannot (digital *in*trepreneuring could though).

(Digital) Entrepreneuring

In Entrepreneurship literature, the body of literature most receptive to studying the role of the digital draws on practice theories (Johannisson, 2011; Steyaert, 2007). This literature sees entrepreneurship as "entrepreneuring", defined as "efforts to bring about new economic, social, institutional, and cultural environments through the actions of an individual or a group of individuals" (Rindova, Barry, & Ketchen, 2009: 477). Digital artefacts, as objects and sites that matter (Leonardi, 2010), affect this process. Indeed, as argued previously, digital entrepreneuring is something different to entrepreneuring within a new context: the opportunities, or action possibilities, that the digital afford entrepreneurs mean that the process of digital entrepreneuring has its own processes, enablers and constraints, as distinct from those in other forms of entrepreneurship.

Digital entrepreneuring in this thesis is thus defined as the process whereby new social and economic practices are produced and reproduced using digital artefacts. I treat digital entrepreneuring, consistent with other practice-based research (Beane & Orlikowski, 2015; Leonardi, 2010), as both a social and a material pro-

cess; that is, one in which entrepreneurial processes take account of the enabling and constraining forces of both social activities and digital artefacts.

Past Entrepreneurship Research

Dominant theoretical views of entrepreneurship rest heavily on the early writings of Schumpeter (1934). Drawing on Austen, he might have characterised entrepreneurship as being an innovation in possession of the right context and in want of a good firm. That is to say, Schumpeterian definitions of entrepreneurship present an approach to entrepreneurship that relies on the presence of innovation, the right conditions, and, ultimately the creation of economic value or wealth (Schumpeter, 1934).

In modern times Low and MacMillan (1988) are credited with the most widely used definition of entrepreneurship (Per Davidsson, Low, & Wright, 2001), wherein entrepreneurship is defined simply as the "creation of new enterprise". This definition, and the accompanying review of developments and challenges for the field preceded an "explosion" of entrepreneurship research (Davidsson et al., 2001).

One co-citation study by Grégoire *et al.* (2006) of convergence in entrepreneurship research found that although entrepreneurship research is broadly fragmented one significant area of convergence has been, relying on Schumpeter's *Theory of Economic Development* into how external constraints, strategic variables, and firm-level orientations lead to the *emergence* of new firms and organisations (*ibid.)*. This stream of research occasionally takes the sensemaking approach epitomised by Weick's early work (e.g. in 1995), but is also likely to include citations around the role of prior knowledge in entrepreneurship (Shane, 2000) or the traits of entrepreneurs that allow them to perceive entrepreneurial opportunities (Kaish & Gilad, 1991). Another area of citation convergence identified by Grégoire *et al.* is in the area of new firm *growth*, with reference to one a number of theories, including the Resource-Based view (RBV) (Durszt, Okrös, Sövényi, Szarvas, & Kovács, 1966; Eisenhardt & Schoonhoven, 1996), Evolutionary Theory (c.f. Nelson & Nelson, 1995) or Absorptive Capacity (Cohen & Levinthal, 1990). A related area of convergence lies in the study of new-venture *performance,* with reference to Competitive Strategy (Porter, 1980), Competitive Advantage (Porter, 2008) and industry structure and competitive strategy (Sandberg & Hofer, 1987). The convergence in these areas shows how much of mainstream entrepreneurship research has both been agent-centric and very rational in its approach; one that focuses on resources, rational strategies and the linear development of the firm, and either divorces them from, or controls for, context.

Two types of entrepreneurship research have responded to this context-free and rational approach to studying entrepreneurship. The first draws on cognitive psy-

chology research and draw on assumptions around bounded rationality (people's ability to act rationally only within some limits, see Weick, Sutcliffe, & Obstfeld, 2005), while the second entails context-specific studies of entrepreneurship.

Cognition in Entrepreneurship

In part, purely rational accounts of entrepreneurship have been supplemented by explorations of behavioural and cognitive issues among entrepreneurs, including how much influence the individual has in the entrepreneurial process (Erikson, 2001). Indeed, Sarasvarthy (2001) argues that entrepreneurs' decision-making processes rarely resemble the rational causal model that involves the recognition of opportunity and a subsequent business plan, as often adopted in entrepreneurship research. As an alternative, Sarasvarthy outlines an effectuation-based theory of entrepreneurial decision-making, an emergent strategy based on control rather than rationality (Sarasvathy, 2001), emphasising how strategy is emergent and based on flexibility and experimentation, as well as what entrepreneurs can control. She describes the causal approach as being like a jigsaw puzzle, in which the entrepreneur takes an existing market opportunity and uses his or her resources to create a sustainable competitive advantage. In this view, all of the pieces of the entrepreneurs' puzzle are treated as present, the entrepreneur must merely think rationally about how to put them together. In contrast, she compares effectuation to a patchwork quilt in which the entrepreneur must be creative, experiment and change direction as new information becomes available (Sarasvathy, 2008).

However, this effectuation view treats the strategies and decisions of entrepreneurs as the focal point of the analysis, with no attention paid to the artefacts that entrepreneurs employ. Thus, although this move away from rationality and trait-based research in entrepreneurship deals with some of the criticisms levelled at the field, such a move doesn't really make inroads into the relationship that entrepreneurship and the entrepreneur has with his/her environment, and the resulting entrepreneurial endeavours.

Phenomena-Based Entrepreneurship

Responding, at least in part, to the criticism that researchers too-often look at entrepreneurship from a single level of analysis, failing to tie together larger contextual issues with the actions of the entrepreneur (Davidsson & Wiklund, 2001), researchers have increasingly turned to context and phenomenon-specific studies of entrepreneurship.

These have included, for instance, corporate entrepreneurship or intrapreneurship, wherein entrepreneurship could take the form of an autonomous unit within an existing firm, an initiative from below, a venture acquisition, a joint venture or a spin-off (Ginsberg & Hay, 1994; Sharma & Chrisman, 1999; Vesper, 1984). The

creation of such firms and activities typically help the parent firm to compete and take risks, and the resources that the parent firms often help entrepreneurship, while their more inflexible organisational structure may adversely affect the firm (Czernich, 2004). Other phenomenon-based entrepreneurship studies include those that explore rural entrepreneurship (e.g. North & Smallbone, 2006), social entrepreneurship (e.g. Zahra, Gedajlovic, Neubaum, & Shulman, 2009), and international entrepreneurship (e.g. Nasra & Dacin, 2010).

In the digital realm, the notion of an open entrepreneur has been proposed as a type of phenomenon-based entrepreneur; wherein entrepreneurship occurs as a result of, and with the support of, an open source community (Yetis-Larsson et al., 2015). Similarly, e-entrepreneurs (Matlay, 2005), internet entrepreneurs (Serarols, 2008) and netrepreneurs (Jiwa, Lavelle, & Rose, 2004) have been suggested as entrepreneurship contained within the phenomenon of the internet. This limited view of the internet as a phenomenon with clear boundaries and limits is however, inconsistent with the view of an infrastructure as something that does not have clear boundaries—and therefore cannot be delimited in the same way as other phenomena, hence the need to explore it, and its implications, through new practice-driven approaches.

Institutional Entrepreneurship

Entrepreneurship, however, may not only be pursuant to Schumpeterian ideas around economic value creation. Instead, the term entrepreneurship has also been used in the context of institutional theory literature to examine how new practices form and how old practices are repeated and thus reinforced whether deliberately (Colomy & Rhoades, 1994) or unintentionally (Lounsbury & Crumley, 2007). In order to be considered such an entrepreneur, an agent must both initiate divergent changes and actively participate in the implementation of these changes (Battilana et al., 2009). This lens on entrepreneurship in an attempt to account for agency in a body of literature that was accused of emphasising structure over agency (Battilana et al., 2009). In order for an actor or group of actors to be considered an institutional entrepreneur, the literature suggests that an actor fulfil two conditions: 1) initiate divergent changes and 2) actively participate in the implementation of these changes (Battilana et al., 2009). Thus, through both cooperation and competition, these actors or groups of actors create conditions that transform institutions, defined as "patterned behaviour infused with meaning by normative systems and perpetuated by social exchanges facilitated by shared cognitive understandings" (Aldrich, 2012).

Studies of institutional entrepreneurship are many and varied, ranging from examinations of the cognitive, structural, and processual barriers to institutional change (Olsen & Boxenbaum, 2009), to how new practices are formed despite

these constraints (Smets et al., 2012). However, what many have in common is that they, like Schumpeterian views of entrepreneurship heavily emphasise the role of the institutional entrepreneur as a hero (Ingram & Clay, 2000). Indeed, the limits—and possibilities—faced by institutional entrepreneurs are almost exclusively large structural ones. The power to change patterns in practice is therefore attributed to individuals or groups of individuals that have significant amounts of power in an institutional field (Garud, Jain, & Kumaraswamy, 2002; Greenwood & Suddaby, 2006), and the technologies that permeate institutional fields have come to be treated as instrumental at best (Seidel, Recker, & Vom Brocke, 2013), or just as catalysts for agent-driven change.

At least one recent study has incorporated a practice perspective; Smets et al. (2012) examine a change in field-level logics when a German and British law firm merge. They both link individual-level practices to broader field-level change, showing the importance of organisational co-ordination for field-level change. Indeed, more broadly they point out that "the practice perspective helps institutional theorists refine explanations of endogenous change" (Smets et al., 2012: 125). Inevitably, however, the underlying dynamics of both change and maintenance are "rife with conflict, contradiction and ambiguity" (Powell et al., 1991: 28). As part of the movement towards materiality in organisation studies, symbolic systems of meaning and "material practices" have begun to form part of analysis (Cloutier & Langley, 2013; Smets et al., 2012). However, as in other forms of entrepreneurship, the digital's role in shifts—and stasis—has thus far remained a silent one.

Table 5: Extant approaches to studying entrepreneurship

Type	Characterisation	Theoretical Underpinnings	Examples
Schumpeterian Entrepreneur	Entrepreneurship as rational, goal-directed and leading to economic outcomes. Emphasises the individual and neglects contexts and artefacts.	Schumpeterian economics, Resource-based view	e.g. Schumpeter 1934; Shane 2000; Aldrich & Martinez 2007
Cognition in Entrepreneurship	Entrepreneurship as the product of bounded rationality, with entrepreneurs focusing on what they can control. Also emphasises the individual and neglects contexts and artefacts.	Bounded rationality, cognitive psychology	Erikson 2001; Sarasvathy 2001; Dew et al. 2009.
Phenomena-based Entrepreneurship	Entrepreneurship within set boundaries and contexts. Could be either cognition-driven or rationality-driven. Explores the effect of context but neglects other material influences on entrepreneurship.	Contextualises Schumpeterian economics, Phenomenology	e.g. Corporate or intrapreneur (Phan, Wright, Ucbasaran, & Tan, 2009; Zahra & Covin, 1995), rural entrepreneur (North & Smallbone, 2006), international entrepreneur (Reuber & Fischer, 2011), open entrepreneur (Yetis-Larsson et al., 2015)
Institutional Entrepreneurship	Entrepreneurship as an institutionally embedded process. However, still focused on the role of either the individual or the structures at work—at the expense of material arrangements.	Institutional theory	Greenwood & Suddaby 2006; Battilana et al. 2009
Entrepreneurship as Process	Entrepreneurship as a process comprised of material arrangements that include both contexts and artefacts.	Practice theory, process theories	Steyaert & Katz 2004; Steyaert 2007; Johannisson 2011

Having discussed extant ways of examining entrepreneurship, summarised in Table 5, I turn now to outlining—and justifying—a digital entrepreneuring approach to understanding entrepreneurship.

Defining Digital Entrepreneuring

Although work in IS has called for a movement away from the conceptualisation of the digital as a set of "tools" by organisation and management scholars (Faraj & Azad, 2012; Orlikowski & Scott, 2015; e.g. Tilson et al., 2010), this call has only begun to be heard by entrepreneurship scholars. In contrast, the desire to take explicit account of the digital has long been familiar to IS scholars (e.g. Leonardi,

2010; Orlikowski, 1992; Orlikowski & Barley, 2001), but they seldom look at studies of entrepreneurship. This is despite the fact that digital artefacts have been shown to be vital for the formation of affordances (e.g. van Dijk, Berends, Jelinek, Romme, & Weggeman, 2011; Volkoff & Strong, 2013), trust (e.g. Benbasat & Wang, 2005), practices (e.g. Orlikowski & Scott, 2015), and other constructs that might affect entrepreneuring.

However, recent advances in thinking among entrepreneurship scholars have created space for consideration of the digital through a move towards a practice theory view of entrepreneurship. Johannison, for instance, argues that such a move takes entrepreneurship scholarship past "rationalistic assumptions taken from the hard sciences" (2011: 138) and instead takes account of the increased importance—and ubiquity—of material elements, both in business and in everyday life (Chia & Holt, 2006; Johannisson, 2011).

Like Sarasvarthy, Johannison demonstrates that entrepreneurship seldom entails neat planning and that attempts at such planning may even be a waste of resources (Johannisson, 2008), given how entrepreneurship, like everyday life, is actually a "flow of disturbances" which may in hindsight be depicted as "logical incrementalism" (Johannisson, 2011: 137). Similarly, Steyaert (2007) suggests that "entrepreneuring" should be used as a verb to explain actions by actors. In his literature review of process-based theories of entrepreneurship (2007), he argues that notions of "growth" and "development" in entrepreneurship are too linear. Instead, he makes calls for research that approaches entrepreneurship as not only multi-disciplinary and multi-paradigmatic, but also as more than a "purely economic reality" (Steyaert & Katz, 2004: 181); which means including digital artefacts and the digital infrastructures that are constitutive of the realities faced by digital entrepreneurs today. Although a material turn has begun to permeate organisation research (Smets et al., 2012; Zammuto et al., 2007), and despite the identification of a need for consideration of the material in entrepreneurship research (e.g. Davidson & Vaast, 2010; Johannisson, 2011), the impact of the digital has yet to be theorised in entrepreneurship research.

The importance of digital objects in entrepreneurship is particularly salient when we consider not only how pervasive digital artefacts are in organising, but also how new firms—and new practices—owe not only their success, but their existence to them. Consider, for instance, the introduction of Facebook. The development of Facebook as a firm was fundamentally shaped by the nature of the artefact that was being "sold". For one, because it was a platform it could provide social media services to consumers while selling the information gathered about them to advertisers in order to pay for development. As a result we can say that the development of the platform and the firm were so intertwined as to be indistin-

guishable; could that business model have existed without the digital platform? Could the firm have existed at all?

At the same time, entrepreneurship based on a digital artefact not only created a new firm, but also a constellation of new practices around it. Indeed, it could be said to have altered how numerous consumers interact with both one another and with content online: enabling real world protests (Tufekci & Wilson, 2012), changing individual mindsets (Thielman, 2016), and, by changing the way in which millions communicate with each other (Goh, Heng, & Lin, 2013) and with organisations (Selander & Jarvenpaa, 2016). Such widespread changes to how individuals interact with technology, and thus the "taken for granted" are both entrepreneurial in the sense that they allow for the creation of new economic value (Per Davidsson et al., 2001), and entrepreneurial in the sense that they create new practices in a "taken for granted" field (Smets et al., 2012).

Applying a practice perspective to the study of entrepreneurship not only contextualises entrepreneurship as a social, rather than merely economic, phenomenon (Steyaert, 2007), but also takes account of the material elements of entrepreneuring; in this case, technology.

This practice perspective is important in that it emphasises action, or the potential for action. Speaking about the study of strategy, rather than entrepreneuring, Rasche and Chia highlight:

> …four elements of social practices which can guide empirical investigations: the routinized behavior of the body, the use of objects, the application of background tacit knowledge in situ, and the constitution of practitioners' identity through practices. We show that research on strategy practices is worthwhile because it directs our attention to often neglected phenomena like the physical nature of strategizing and the way objects enable and limit bodily and mental activities. (2009: 717).

In emphasising the actions, in context, of entrepreneurs, such an approach avoids some of the pitfalls of entrepreneurship research. The first of these is treating the entrepreneur as a "hero", or some unique class of individual rather than taking the more generous view that entrepreneurs are products of their contexts (Sarasvathy, 2004). In the same vein, this practice perspective takes into account the implicit effects of the digital realm as an environment in which entrepreneurial practices take place.

Thus far, I have examined why I was interested in the phenomena that I was, and how studying them—digital entrepreneuring and digital infrastructures in particular—necessitated a practice-based approach. While such an approach builds on extant literature, it nevertheless represents a thoroughly different way of examining these concepts. I turn now to discussing the contributions of this thesis.

Thesis Overview

This thesis is comprised of five papers (Chapters 2-6, summarised in Table 6, visualised in Figure 1) and this introductory chapter (Chapter 1).

Table 6: Papers included in this thesis

Ch.	Title	Authors	Outlet	Research question
2.	Generativity in the Bitcoin Online Community: Code Forking as Generating Digital Infrastructure(s)	Andersen, JV and Ingram Bogusz, C.	Working paper (Aim: *Journal of the Association for Information Systems* Special Issue on "Opportunities and Challenges of Blockchain Technology")	What is the role of code forking in digital infrastructures in the organisation of OS communities?
3.	Taming digital flexibility: An embeddedness approach to entrepreneurial activity	Ingram Bogusz, C.	Submitted to *Research Policy*, Special Issue on Digitization of Innovation and Entrepreneurship	How can we understand the effect of embeddedness on the flexibility of entrepreneurship using digital infrastructures?
4.	Platform use takes more than trust: Designed legitimacy on a crowdfunding platform	Ingram Bogusz, C.; Teigland, R; and Vaast, E.	*European Journal of Information Systems* (conditionally accepted)	How can a two-sided crowdfunding platform come to be seen as legitimate?
5.	How infrastructures anchor open entrepreneurship: the case of Bitcoin and stigma	Ingram Bogusz, C. and Morisse, M.	*Information Systems Journal*, Special Issue on Digital Entrepreneurship (third round review)	How does ideology affect open entrepreneurs' responses to stigma?
6.	Coding for collective action: the case of the digital economic social movement of Bitcoin	Ingram Bogusz, C., and Andersen, JV.	Submitted to *Information & Organization* Special Issue on Collective Action, Social Movements and Digital Technology	How does collective action emerge in the digital economic social movement of Bitcoin?

Initially; I was interested specifically in entrepreneuring with digital infrastructures. Chapters 4 and 5—both about digital entrepreneuring—were, chronologically, the first two papers that I wrote. However, as my co-authors and I developed these papers, I felt that I wanted to explore the antecedents of digital entrepreneuring at the infrastructure level (Chapters 2 and 3), as well as digital entrepreneuring "writ large", or a social movement pursuant to changes in digital infrastructures (Chapter 6).

In writing this introductory chapter, I pieced together how these papers fit with one another. As writing a thesis is usually not a linear process, the fit is not perfect, but figure 1 gives a good illustration of how these paper advance our understanding of both digital infrastructures, and their role in digital entrepreneuring.

In the sections that follow, I will 1) give summaries of the five papers in this thesis, 2) describe how each individual paper contributes to the larger aim of understanding the role of digital infrastructures in digital entrepreneuring, 3) discuss the theoretical implications of these findings, over and above the implications contained in the individual papers, and 4) discuss their implications for practitioners.

Zooming in: Chapters 2-6

Chapter 2: Coding as Organising: Code Forking and Generativity in the Bitcoin Community

Literature on digital infrastructures typically emphasises how digital infrastructures emerge from the organising practices of human actors (Star & Ruhleder, 1996; Yoo et al., 2012). However, these literatures also describe digital infrastructures as being themselves generative (Zittrain, 2006)—suggesting that there in something inherent in the digital that not only leads to unintended outcomes, but also that facilitates, variously, organising, infrastructural developments, and other emergent outcomes.

Existing theoretical views of infrastructures focus on digital infrastructure evolution through adaptation by users (e.g. Hanseth & Lyytinen, 2010), inscription by coders (e.g. Yoo, Lyytinen, & Yang, 2005), interaction with users (e.g. Fang & Neufeld, 2009) or through choices made by designers (e.g. Broadbent & Weill, 1997). However, these conceptualisations of digital infrastructure evolution emphasise the role of social actors at the expense of the infrastructure itself.

If we take seriously the idea that an infrastructure is fundamentally something which supports some organised relational practice through which it is actualised (Star, 1999), we need to also examine the role that generative infrastructures play in their own evolution as a consequence of their digital materiality (Hanseth & Aanestad, 2003; Henfridsson & Bygstad, 2013).

This empirical paper examines a case in which a community is nested in a digital infrastructure, rather than vice versa (as in Star & Ruhleder, 1996). This allows us to examine the role of a digital infrastructure in its own evolution, even as flexible digital infrastructures and organisation co-evolve (Tilson et al., 2010), delving into the research question:

> What is the role of code forking in digital infrastructures in the organisation of OS communities?

We find that the digital code "fork", where code variations split off from a core code base, allows for re-organisation within a digital infrastructure. Moreover, we identify three types of code forks that lead to three different infrastructure evolution trajectories at the digital level, namely through processes of speciation (hard forks), adaptation (developmental forks) and variation (pseudo forks).

Our overall contribution is therefore to 1) conceive of the role of the digital infrastructure in its own generativity, 2) links extant literature on code forking to infrastructure evolution literatures, and 3) illustrate and identify fork-based mechanisms whereby organisational evolution occurs.

Chapter 3: Taming Digital Flexibility: An Embeddedness Approach to Entrepreneurial Activity

Socially constructed "rules of the game" (Meyer & Rowan, 1977: 341) in which activities are embedded have long been said to both constrain and enable social activity (Giddens, 1984). Digital infrastructures, as both technical and social in nature, are not immune to these effects. However, we know little about how embeddedness affects economic activities that rely on operation, perpetuation and flexibility. Indeed, extant research on digital infrastructures have focussed on their flexibility and generativity. Embeddedness and its effect on the possibilities around infrastructure evolution and generativity have not yet been theorised. Instead, the limits to infrastructure flexibility have been framed in terms of convergence (e.g. Hanseth, 2000), with reference to boundary resources (e.g. Eaton et al., 2015), and through individual, designed-in points of control (e.g. DeNardis, 2012).

This paper responds to the research question:

> How can we understand the effect of embeddedness on the flexibility of entrepreneurship using digital infrastructures?

This conceptual paper develops a multi-level model of the effect(s) of embeddedness on entrepreneurship reliant on digital infrastructures, as relational arte-

facts. It argues that field-level embeddedness, and the imperatives of compatibility and shared use limit how much an infrastructure can be developed. At the field level, shared symbolic systems and accepted norms around how digital artefacts are used in practice mean that an infrastructure cannot develop in such a way as to be inconsistent with its initial form and function. On the inter-organisational level, embeddedness has meant that the importance of co-ordination, the re-use of knowledge resources and the importance of network effects limits what can be built upon an infrastructure in the form of platforms and modules. Lastly, when it comes to dyadic embeddedness, standardised work processes and tighter coupling mean that embedded frameworks for judging which behavioural, organizing, discursive, and interaction patterns are appropriate (i.e. accepted as "legitimate", Colyvas & Powell 2006) place limits on the flexibility of economic activity based on the infrastructure.

Chapter 4: How Infrastructures Anchor Open Entrepreneurship: The Case of Bitcoin and Stigma

In general, stigma has led established firms to distance themselves from the source of the stigma, whether by divesting of tainted assets (Durand & Vergne, 2014) or through reasserting their own legitimacy by denial, defiance and decoupling from the source of the stigma (Lamin & Zaheer, 2012). However, accommodating the source of the stigma through responding to it has also been observed to be effective—and actually helps the firm recover (Lamin & Zaheer, 2012).

Entrepreneurs who operate using a common underlying technology, however, rely heavily on a shared common digital infrastructure. They also stand to obtain benefits from their business from their involvement in the Bitcoin OS community (Simon, von Krogh, Leonard, & Swap, 2004), that may help them weather the storm of stigma. Stigma literature and OS community literature thus conflict when it comes to understanding how Bitcoin entrepreneurs might respond to stigma. Accordingly, we ask the question:

> How do open entrepreneurs in the Bitcoin community form stigma responses?

This empirical paper builds on interview data from Bitcoin entrepreneurs in Northern Europe and forum data from bitcoin.org.

We find that the technical infrastructure "anchors" the entrepreneurs, despite diverse ideologies and diverse business models. This occurred through a) the anchoring of multiple identities in a diverse community, b) the imperative to contribute to the community.

Moreover, we contribute to research around ideologies in OS communities. Using language drawn from studies of group identity (Ashforth & Johnson, 2001; Pratt & Foreman, 2000), we develop a model of stigma response strategies by Bitcoin entrepreneurs.

Chapter 5: Platform Use Takes More than Trust: Designed Legitimacy on a Crowdfunding Platform

Entrepreneurs in all fields are often seen as not having legitimacy when they begin their journey (Suchman, 1995). This paper examines how the use of digital artefacts—and a platform, in particular—might affect attempts by entrepreneurs to gain legitimacy. Through a theory-building, qualitative study of a crowdfunding platform, we ask the research question:

> How can a two-sided crowdfunding platform gain legitimacy?

We found that legitimacy is something that can, when working with a digital platform, be designed for. This is consistent with earlier research, which links legitimacy-building to the use of symbols, narratives, and material to indicate institutional conformance, most notably language and semantics are used (Garud, Schildt, & Lant, 2014; Martens, Jennings, & Jennings, 2007), and infrastructure (de Vaujany & Vaast, 2014). Symbols in the digital realm are, however, widely used in digital artefacts, for instance through in online branding (Rowley, 2004) or to convey identity online (Ma & Agarwal, 2007). However, they have never before been used to study legitimacy-building online.

The main finding of this paper is that a platform is capable of not having legitimacy (as was the case in our empirical study), suggesting that a platform could also be seen as legitimate. This paves the way for future research into what it would take for such a platform to be perceived as legitimate. Moreover, the absence of legitimacy hints at the notion that legitimacy, as a social practice artefact (Deephouse & Suchman, 2008), can be attributed to a technological artefact.

We offer the concept of "designed legitimacy", which we define as "requires designing an artefact that, by virtue of its design, is compliant with key actors' normative expectations in the field. It entails strategic legitimacy-building (Suchman, 1995) in that the features of the platform, and associated narratives, need to be presented as consistent with existing norms in order to attract key actors" as a way to obtain this legitimacy.

We also find, consistent with earlier research (e.g. Garud et al., 2014) that (digital) narratives and stories articulated in the pursuit of legitimacy may themselves create new constraints or barriers to obtaining legitimacy. In this case, two-sided

platforms have to build legitimacy using online artefacts with *both* of their user bases, and that the requirements of this legitimacy building may be both competing and mutually exclusive. However, in this case it appeared as though legitimacy-building was a two-stage process as legitimacy with one group required being perceived as legitimate by the other.

Chapter 6: Coding for Collective Action: The Case of the Digital Economic Social Movement of Bitcoin

The belief that technology can solve both large and small social problems (e.g. Libert, Beck, Komar, & Estrada, 2017; Toyama, 2015) is widespread. While digital technologies like social media and forums have played outsized roles in everything from protests (Tufekci, 2014) to activism (Selander & Jarvenpaa, 2016), technologies have not yet been proffered by social movements as alternatives to existing social institutions. The Bitcoin infrastructure has been presented as an alternative to a state-led financial system—depicted as overly centralised, meddlesome and untrustworthy—and to untrustworthy and inefficient banks (Nakamoto, 2008) by the Bitcoin economic social movement.

However, digital infrastructures, like social movements, are controlled by dispersed individuals. It can therefore sometimes be hard to generate the social momentum needed to overcome certain problems. One of these problems is the collective action problem. That is, a problem that requires collective action in order to overcome—but where there is no clear individual incentive to act, or even an incentive for individual members of the collective to 'free ride' (Schelling, 1978).

Research on digital infrastructures has highlighted the generative capacity of digital infrastructures, and the social evolution of the social movement is therefore tied up in the generative capacity of the underlying infrastructure—through its source code—in line with changing social and economic goals (Hanseth & Aanestad, 2003; Henfridsson & Bygstad, 2013).

In order to examine how collective action occurs in economic social movements, we therefore ask:

> How does collective action emerge in the digital economic social movement of Bitcoin?

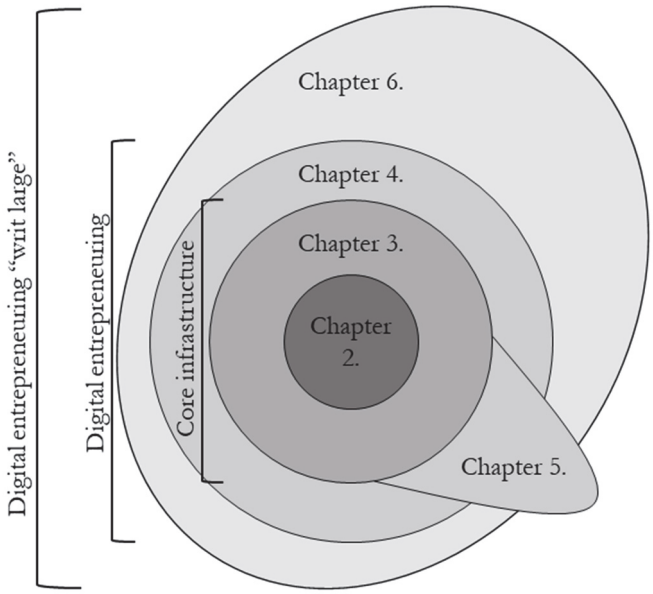
We found that digital infrastructures mediate in such a social movement, and develop an understanding and vocabulary to talk about a digital economic social movement. Code, which is the substrate of such a movement, consequently leads to a) a novel form of collective (in)action; b) new frames for meaning and legitimacy, and c) ways for digital code to translate into social action, and vice versa.

Having discussed the individual papers contained in this thesis, I turn now to discussing their contribution(s) to the larger research question in this thesis.

Zooming Out: the Bigger Picture

As mentioned in the Introduction to this thesis, the overarching aim of this thesis is to explore how digital infrastructures and digital entrepreneuring interact and lead to the emergence of new infrastructures, in this case new financial infrastructures. The papers in this thesis map an intellectual journey and interests that have developed over the past four years. They therefore all lend themselves to helping us understand this overarching aim in different ways, and from different perspectives (see Figure 1).

Figure 1: How these thesis chapters contribute to our understanding of digital infrastructures, including where digital entrepreneuring results.



Taken together, they build layers of understanding around the functioning of digital infrastructures, themselves relational, through an examination of forks (Chapter 2) and embeddedness (Chapter 3) I have labelled this understanding "Core Infrastructure"—although this is shorthand, given that infrastructures can never be fully divorced from the social context in which they are used and perpetuated.

Building upon this understanding of Core Infrastructures, I look at how digital entrepreneuring, as an infrastructure-mediated set of practices occurs, teasing out the impact of infrastructures themselves (Chapter 4), and on platforms that rely on

the infrastructures (Chapter 5). I have labelled this "Digital Entrepreneuring". Lastly, I examine how Digital Entrepreneuring can be scaled up, or "writ large" through a social movement (Chapter 6).

Core Infrastructure

The first two papers in this thesis zoom in on the composition of digital infrastructures, and examine how their digital composition, and code in particular, affects what can and cannot be done with them—whether through entrepreneurship or otherwise. The first of these examines the generative potential of digital infrastructures through an examination of code forking. Through an examination of the Bitcoin blockchain, where the designers of the infrastructure built it and then disappeared, we show how the digital infrastructure itself, through forking, plays a role in its own use and perpetuation.

The shared norms in an OS community mean that forks are typically frowned upon, largely because multiple, incompatible versions of a software can discourage related future developments (Meeker, 2008; Nyman, 2015). However, in order for an infrastructure to evolve, it needs to respond to its environment, and it is very have for a large and distributed community to come to a consensus about the future of an infrastructure. Forks become the infrastructure-anointed way to create new patterns of organising, and enshrine the rules for such organising in the substrate of the new organisation: as forked code.

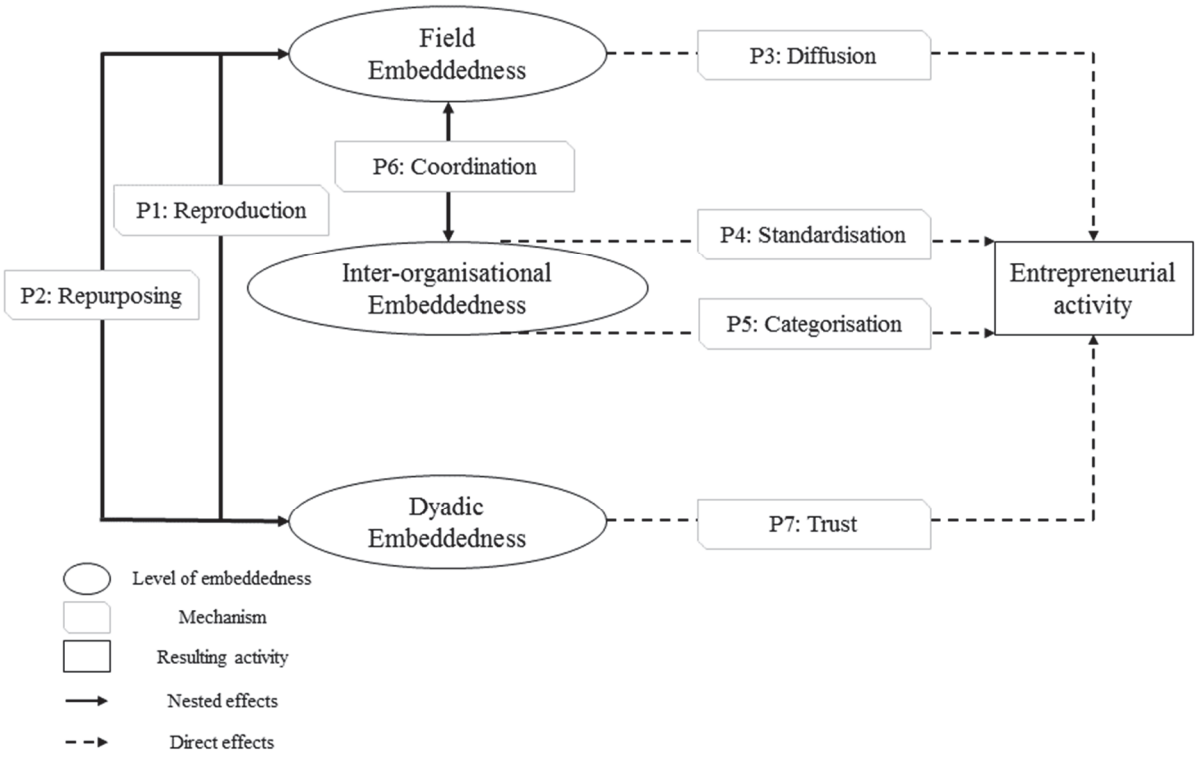
Chapter 2 identifies three different technical changes to the underlying infrastructure, and the implications that they have for organising through an empirical examination of the Bitcoin OS community. First, *hard forks;* they lead directly to new organisational outcomes though *speciation*, and rely on a complete code-level shift. Second, *code development*, which extends the extant source code, leading to supplementary organising and links to other organisations through *adaptation*. Third, the repurposing of existing code through *pseudo-forks*, which leads to similar outcomes through *variation*.

These digitally encoded and infrastructure-mediated forms of organising are both reliant on the initial infrastructure and on the organisational influence of the original infrastructure. This is reflected in the coded-in, rules around how the organisation is structured; in this case, these rules included decentralisation, the distribution of power, the immutability of consensus-building, and democracy as the final arbiter of decision-making processes.

It should be noted that this paper has links to Chapter 6; not only do forks allow for organising, they also allow social movements to organise themselves more effectively.

Chapter 3 examines the embeddedness of entrepreneurship in digital infrastructures. It proposes a number of propositions that might guide future research into how infrastructural embeddedness impacts flexibility of entrepreneurial activity. As such, it draws on patterns of diffusion (e.g. Loh & Venkatraman, 1992; Lyytinen & Damsgaard, 2011), maintenance (Ghazawneh & Henfridsson, 2013; Leimeister, Ebner, & Krcmar, 2005; Moon & Sproull, 2008), reproduction (Baskerville & Myers, 2009; Swanson & Ramiller, 2004; Wang, 2010), and control (Eaton et al., 2015; Gosain, 2004) as they apply to entrepreneurship reliant on digital infrastructures. These propositions are summarised in Figure 2.

Figure 2: Multi-level and nested embeddedness of entrepreneurial activity reliant on digital infrastructures



Digital Entrepreneuring

Although Chapter 3 theorises about the effects of digital infrastructure embeddedness on entrepreneurship, the next two papers take studies of entrepreneurship a step further: by examining digital entrepreneuring mediated by a new infrastructure (Chapter 4), and a platform (Chapter 5). In particular, these papers zoom in on a problem that entrepreneurs face at an early stage: obtaining legitimacy.

The first of these examines how the stigmatisation of a core digital infrastructure anchors digital entrepreneurs in that stigma, while the second examines how the design of a crowdfunding platform is vital to whether (and how) it comes to be seen as legitimate by a possible user base.

Having legitimacy, in institutional theory, has entailed conformity to normative, structural and cognitive norms within a field (Suchman, 1995). However, new actors—and entrepreneurs in particular—are often the pioneers of improvements (or changes) to existing norms (e.g. Tornikoski & Newbert, 2007). They may therefore not yet have legitimacy because their firms are mediated by technologies that have not yet received widespread acceptance (van Lente, 2012) or because they operate from the periphery of a field (Henfridsson & Yoo, 2014; Wright & Zammuto, 2013). Such legitimacy exists along a spectrum; on the one end actors can be seen as legitimate, but they can also be seen as not having legitimacy, being completely illegitimate, or stigmatised.

They may therefore be seen as illegitimate, or stigmatised, because they challenge—or reject existing norms. As such, stigma is said to be "a collective stakeholder group-specific perception that an organization possesses a fundamental, deep-seated flaw that deindividuates and discredits the organisation" (Devers, Dewett, Mishina, & Belsito, 2009: 157).

Chapter 4 shows empirically how stigma affects the ideologically diverse members of the Bitcoin OS community differently, including entrepreneurs in this community, when the underlying infrastructure experiences stigmatisation—although the cause is unclear.

This paper shows that an infrastructure, itself a relational entity. "anchors" divergent ideological groups, preventing them from distancing themselves from the OS community under conditions of stigmatisation. This is counter-intuitive: entrepreneurs could "free-ride" on the OS community, but choose not to. We also develop a model of how sub-groups within the Bitcoin community make use of ideology in articulating their stigma responses through group membership *identification*, stigma *interpretation,* business model *enactment,* and response *salience*. Ultimately, this paper shows how responding to stigma while digital entrepreneuring reliant on digital infrastructures constrains the possible responses, but means that even ideologically diverse entrepreneurs support one another.

Chapter 5 shows empirically how a failure to build legitimacy might occur when digital entrepreneuring through a platform (as just one artefact in a digital infrastructure). In the case of this crowdfunding platform, design elements meant that the platform failed to be seen as providing a conduit for legitimacy—just meaning that it could not be seen as legitimate itself.

This paper proffers a number of propositions around how *designed* legitimacy might be obtained, something that is fundamentally different to legitimacy-building

in the absence of a mediating digital artefact. We further develop propositions around legitimacy building mediated by this particular kind of digital artefact, namely a two-sided platform. In particular, we look at asymmetric and two-stage legitimacy building.

Digital Entrepreneuring "Writ Large"

As both Steyaert and Katz (2007; 2004) and Davidsson and Vaast (2010) point out, entrepreneurship is partly about the underlying economic endeavour that entrepreneurs undertake and partly about the social consequences of the economic endeavour. This means that a truly practice-based approach to the study of internet entrepreneurship can scale and look at how the economic "entrepreneuring" affects social "entrepreneuring".

Chapter 6, the final paper in this thesis, examines the relationship between a digital infrastructure and a social movement in the case of Bitcoin. It finds that the codification of meaning by a social movement creates new conditions under which collective action can occur. Looking back on this paper, I would like to call this "distributed consensus"—and perhaps will have the opportunity to revise the paper in line with this in the future.

This paper offers an empirical example of a digital economic social movement, a case in which a digital infrastructure is proffered to replace existing financial infrastructures. It further shows empirically how digital infrastructures mediate, leading to a) a novel form of collective (in)action; b) new frames for meaning and legitimacy, and c) ways for digital code to translate into social action, and *vice versa*.

Overall, these papers reveal three patterns that span infrastructures, showing how the practices of digital entrepreneuring together with digital infrastructures are fundamentally different to entrepreneuring without them.

Contributions

In the introduction to this thesis, I presented my overarching research aim, namely: understanding how does the interplay between digital infrastructures and digital entrepreneuring leads to new financial infrastructures emerging? Building upon existing understandings of digital infrastructures as embedded, complex relationships between social activities (Star, 1999; Star & Ruhleder, 1996) and technical artefacts (Tilson et al., 2010; Yoo et al., 2010), this thesis teases out the fabric of digital infrastructures in the form of code (Chapters 2, 3 and 6), as well as the "fabric" of social interactions through perceptions of legitimacy (Chapter 5), and ideology and group identity (Chapter 4).

The main contributions of this thesis are 1) a conceptualisation of digital entrepreneuring as a concept, situated within IS literatures; 2) a deeper understandings the role of digital infrastructure in affecting organising in general, specifically through code and design elements and 3) a deeper understanding of digital infrastructures' role in digital entrepreneuring, especially around legitimacy and consensus.

The Concept of "Digital Entrepreneuring"

Building on the concept of "entrepreneuring", which already exists on the fringe of mainstream entrepreneurship research (e.g. Johannisson, 2011; Mair, Battilana, & Cardenas, 2012; Steyaert, 2007), I develop a conceptualisation of "digital entrepreneuring", as a way of studying entrepreneurship mediated by DITs, namely through the practices that result from interactions between the two.

These infrastructure-level changes show that studies that treat digital entrepreneurship as a sub-type of entrepreneurship (e.g. as e-entrepreneurship (Matlay, 2004) or as entrepreneurship in the internet economy (Jiwa et al., 2004)) miss much of the activities that give entrepreneurship in the digital realm its unique nature (Nambisan, 2016). Indeed, digital artefacts play far more of a role in digital entrepreneurship than artefacts have done in any other area of entrepreneurship research, making information systems a more natural home for such research.

However, pursuant to the development of this concept, this thesis also presents findings that have implications for IS; entrepreneurship and organisation studies.

Digital Infrastructures in Organising

Social and Technical Embeddedness

Although previous studies of infrastructure developments, for instance of electricity (Sine & David, 2003), telephones (Sawhney, 1992), and railroads (Jahanshahi, 1998) have exhibited embeddedness, the scale of this embeddedness in the case of digital infrastructures is larger than ever before seen. In other words, the dynamism, flexibility and generativity of digital infrastructures makes them far more complex—and unpredictable—than non-digital infrastructures (Tilson et al., 2012).

This thesis shows the social and technical embeddedness of digital infrastructures and the implications of this for organising. In particular, it highlights, empirically how this embeddedness affects legitimacy building and perception (Chapter 5) and stigma response (Chapter 4). Theoretically, it highlights the role of co-

ordination, the re-use of knowledge resources, network effects, standardised work processes and tighter coupling in limiting entrepreneurial flexibility through infrastructure embeddedness (Chapter 3)

These complex and multi-level ways in which activities and infrastructures are embedded in one another not only make organising using digital infrastructures unique, they constrain future entrepreneuring in ways that we have not yet conceived of (and some we have, see Chapter 3). Indeed, it has been observed that digital firms like Facebook and Google have come to dominate online economic activity in ways never before conceived of (Dwyer, 2017; Garrahan, 2016; Sherman, 2017). The fact that they control artefacts that are fundamental to most modern social life explains some of this dominance.

New Forms of Distributed Consensus

Both code and group identities serve as ways for distributed groups of heterogeneous individuals, mediated by technology, to come to consensus about infrastructure evolution. In the context of digital entrepreneuring, this is done through goal-directed practices, with the aim of economic value creation (Nambisan, 2016).

Code, in particular, does this by making potential changes concrete and transparent (Chapter 6), lowering the costs of information search and collaboration for distributed individuals. Moreover, it is both inscribed with social attributes (Chapter 6), and generates social outcomes through organising (Chapter 2) and through its complex webs of embeddedness (Chapter 3). Despite this important mediating role, however, unintended consequences may still result (Zittrain, 2006).

Group identities online allow for distributed consensus by connecting those with shared interests and identities that might not otherwise have met. The democratising nature of DITs (Chesbrough, 2003) means not only that more individuals are involved in innovation and entrepreneurship, but also that those with very niche interests or identities can find one another and rally together despite geographic barriers. The result is that they are able to form a critical mass online, where they might not have been able to rally the numbers in an offline environment (see Chapters 4 and 6).

Digital Infrastructures' Role in Digital Entrepreneuring

Code and Design Mediate

In a digital environment where competition is fierce, resources are scarce and the "rules of the game" unclear, digital entrepreneuring is particularly interesting—but

tricky. In particular, new ventures face so-called "liability of newness" (Suchman, 1995) and have to become seen as legitimate. The status of being "legitimate" or "stigmatised" is a social, relational characteristic. In the past, it has been treated as something that only human relationships can convey or contain (Suchman, 1995; Weber, 1978; Zimmerman & Zeitz, 2002).

Such relational characteristics have begun to be attributed to technologies (Benbasat & Wang, 2005). This because people do, in fact, treat computers and other digital artefacts as though they are more than simple tools (Reeves & Nass, 1996), and also makes sense given the relational nature of digital infrastructure(s). However, while the technologies may have relational properties, the manner in which such technologies mediate relational outcomes (or not), for instance legitimacy, is poorly understood.

This thesis builds on these understandings by showing specifically how legitimacy may be something that is actually built into a platform (Chapter 5), taking into account symbols and narratives (Garud et al., 2014). This designed legitimacy differs from offline legitimacy in that it (potentially) allows digital entrepreneurs to appeal to multiple interest groups simultaneously, as well as build legitimacy asymmetrically through designed-in elements.

Moreover, elements of code mediate to lead to organisational and infrastructural outcomes, including new organisational forms (Chapter 2), and clearly defined social rallying points characterised by being at the intersection of social and technical needs (Chapter 6).

Anchored in Communities and Infrastructures

Researchers have pointed to how one identity (offline) can limit the expression of another identity (online), or "anchor" it (Zhao, Grasmuck, & Martin, 2008). Here, social dynamics offline anchor the perception of a platform's legitimacy (Chapter 5), and a digital infrastructure anchors diverse groups of entrepreneurs, limiting their options when it comes to, among other things, stigma response (Chapter 4).

This anchoring means that individuals embedded in common infrastructures, whether technical or social in nature, become so closely tied to one another that despite considerable differences they must respond and interact with one another. This anchoring is important when one considers how standards in the digital world have become commonplace, and how convergence onto single infrastructures with multitudes of modules have been describes as the likely eventual outcome (Yoo et al., 2012).

Having discussed the theoretical implications of this Introductory Chapter and the Chapters contained in this thesis, I turn now to discussing their implications for practitioners.

Implications for Practitioners

Entrepreneurs are not the only actors that are being affected by digitalisation, and making use of digital infrastructures. This thesis has, in particular, two main implications for practitioners, whether entrepreneurs or otherwise.

Designing (and Coding) for Social Outcomes (not just Functionality)

This thesis shows that both design and the content of the code that comprises a digital artefact (especially artefacts that are subsequently rendered infrastructural) affects organising, both directly and indirectly.

Artefacts are increasingly being released as "minimum viable product"; that is, as artefacts with only the most basic necessary functionality (Blank, 2013). While this provides entrepreneurs and organisations with a certain amount of agility, it comes at a cost: basic functionality may have unintended social consequences. This approach should therefore be tempered by consideration of the social needs of users and supporters. This could be done in at least ways.

First, digital artefact design, whether its user interface or back-end operations, is often done separate from the main business of an organisation (Cross, Cowen, Vertucci, & Thomas, 2009). Those wishing to integrate the social needs of potential users and customers into artefact design are advised to involve those with knowledge of their social needs into artefact design. Indeed, practitioners are urged to consider carefully how they plan and implement their artefact design and implementation and, if possible, to bring it within the purview of those responsible for strategic decisions and client relationships; both design and code will affect these at least as much as purely social interactions.

Second, digital artefact design could be done with the social affordances of existing infrastructures in mind. For instance, artefacts designed for Facebook use should be designed to highlight Facebook qualities that suit their needs (e.g. "friendly" interface), while mitigating against association with some of the qualities they do not wish to be associated with (e.g. opaque retargeting practices).

This advice is directed particularly to entrepreneurs, who build legitimacy and organising from the ground up, but it advice that may aid established firms—particularly those in finance—that are adapting in response to digitalisation.

Closer Ties

The use and perpetuation of digital infrastructures has given rise to more connections between digital artefacts, organisations, and groups of individuals than ever

before imagined. This proliferation of connections means that individual organisations have to be increasingly mindful of the web of interdependencies created as a result of their DIT choices.

Code standards, for instance, affect whom they can employ to develop digital artefacts, as well as with which other artefacts, and code forks may make them more—or less—reliant on common digital infrastructures like Google, SAP and others. While there are extensive benefits to be had from open innovation and other crowd- and OS-based innovations (e.g. Hippel & Krogh, 2003; Spaeth, Stuermer, & Krogh, 2010), choice of DIT—and control of DIT—is increasingly important.

Practitioners are therefore advised to be cautious when choosing service providers, and investigate their interdependencies as much as it reasonably possible. For instance, data stored in a third party warehouse may be more, or less, accessible to hackers or scam artists, depending on that third party's choice of DITs, coding language, and even location. These are therefore all things that a practitioner should take into account—and proceed with high caution until more is understood about how digital infrastructures emerge, their flexibilities, and how to control them.

Mindful of Social Meanings Attached to Technologies

What this—and other—research has shown, fairly robustly, is that technologies can no longer be considered mere "tools" in the pursuit of economic value creation (Drori et al., 2009; Orlikowski, 2010). Instead, they attract social meanings, including legitimacy and stigma, in their own rights.

These legacies are hard to break. Accordingly, once a technology has attracted a certain social meaning (e.g. in Chapter 4), it is hard to move away from it—even when the source of the meaning is unclear.

These social meanings may also not be unified or heterogeneous; technologies may mean different things to different people depending on, for instance, their ideologies or the other groups with which they most closely identify.

When it comes to pioneering new (and old) technologies, it is therefore not enough for organisations to overlay their own sets of meanings on a technology; the legacy of the meanings associated with the technology will anchor the organisation, no matter what it chooses to do. These associations can, of course, be positive. However, given the impact of negative social meanings, and their longevity, it is therefore important that organisations pioneering new services and products mediated by new technologies tread lightly, and that organisations making use of known technologies (e.g. distributed ledger technologies) consider pre-existing social meanings as part of their commercialisation strategies.

Having discussed both the theoretical and practical implications of this research, I turn now to discussing its limitations and presenting some suggestions for future research, before concluding.

Limitations and Directions for Future Research

This thesis has just dipped its proverbial toe into the depths of both digital entrepreneuring and digital infrastructures. As such, the directions for future research are considerable.

First, this thesis only looks at the earliest stages of digital entrepreneuring, specifically while entrepreneurs still experience liabilities of newness. How digital entrepreneuring in general, and specifically digital entrepreneuring mediated by digital infrastructures, occurs the whole way through the entrepreneurial process is therefore ripe for investigation. This thesis presents in Chapter 3 a number of propositions for future investigation, but the possibilities are nearly limitless.

Second, the role of code and design in organising, digital entrepreneuring and other relational processes is still emergent. While design thinking is fairly well established in IS scholarship (e.g. Heinrich & Riedl, 2013; Helms, Giovacchini, Teigland, & Kohler, 2010; Von Krogh & Haefliger, 2010), it has yet to reach entrepreneurship and entrepreneuring. Similarly, while code is reasonably well-understood in technical journals, its role as an arbiter of change (and stability) in social or relational situations is poorly understood.

Lastly, embeddedness. I have only skimmed the surface there too. As Terry Pratchett in *Small Gods*, among others, might have said: "it's no use--it's turtles all the way down!", when it comes to the digital and the relational.

The single biggest limitation is the relatively large changes that both financial infrastructures and other infrastructures have seen as a result of digitalisation. These studies, as case studies within this larger context, therefore run the risk of only having captured some of the complexity of what is occurring (Gibbert, Ruigrok, & Wicki, 2008), despite my best efforts to dig deeper through the use of multiple data sources, multiple methods, both empirics and theory, and the use of longitudinal data. Moreover, these changes are still emerging—so the findings that I present here, while robust at the time of writing, may need to be revised as digitalisation continues in the financial sector.

Conclusion: Entrepreneuring in Emerging (Financial) Infrastructures

Over the 4 years it has taken to write this thesis, drastic changes to financial infrastructures have emerged, both through entrepreneuring and what one might call "*in*trepreneuring".

Drawing on research around digital artefacts and infrastructures in the information systems literatures, I described how digital artefacts have either been ignored, treated as an exogenous force or as mere products of human agency in the past (Orlikowski, 2010). In a day and age when digital artefacts are integral to entrepreneurial endeavours, and where constellations of digital artefacts have come to form infrastructures upon which entrepreneurs rely, I aimed to understand their role in relational processes, specifically entrepreneuring.

This integral role, where digital artefacts and infrastructures influence what is possible and what is not when it comes to entrepreneuring has led to new practices, or what I call "digital entrepreneuring". The practices themselves have emerged from a combination of the old and the new. Existing norms are still important (e.g. in Chapters 5 and 6), but digital infrastructures play a significant role in communication, legitimacy, and in organising.

This is because the emergence of new financial infrastructures is mediated both by digital infrastructures and digital artefacts, and by the relationships that actors have with these artefacts. The relationships that tied these constellations of activity together in this thesis included embeddedness (Chapter 3) and anchoring (Chapter 4), but there are likely many more relationships that both help and hinder the emergence of new digital infrastructures.

These multiple, distributed relationships are characteristic of digital infrastructures (Yoo et al., 2012). However, digital infrastructures also provide ways for distributed actors to coordinate, especially through code forks (Chapter 2), and by making decisions concrete through code, reducing the costs of information searching and coordination (Chapter 6). Despite these coordinating functions, new digital (financial) infrastructure emergence is, as Susan Leigh Star describes:

> [Infrastructure] is fixed in modular increments, not all at once or globally. Because infrastructure is big, layered, and complex, and because it means different things locally, it is never changed from above. Changes take time and negotiation, and adjustment with other aspects of the systems are involved. Nobody is really in charge of infrastructure. (1999: 382)

As a result, the changes to the underlying infrastructure are not only distributed and piecemeal, the artefacts added and subtracted lead to social dynamics in their own right. These social dynamics include, but are not limited to: a) distributed consensus, b) anchoring, and c) embeddedness.

Capturing these dynamics, however, is easier said than done—and this thesis took a practice-inspired approach to studying entrepreneuring mediated by DITs, or what I call "digital entrepreneuring" in order to capture these dynamics.

This thesis adds to the burgeoning literature showing empirically the importance of digital artefacts in their own use and perpetuation (Leonardi, 2013; Orlikowski & Robey, 1991), in this case in digital entrepreneuring. It shows how digital entrepreneuring is fundamentally different than entrepreneuring outside of the digital realm insofar as mediation by the digital fundamentally alters entrepreneuring processes.

In summary, this thesis makes three main contributions. First, it explores, describes and justifies a conceptualisation of "digital entrepreneuring", situated within IS literatures. Second, it gives us a deeper understanding of the role of digital infrastructure in affecting organising in general, specifically through code forking and the designing-in of symbols and interactions to support relational outcomes. Third, it outlines a deeper understanding of digital infrastructures' role in digital entrepreneuring, especially when it comes to (il)legitimacy and consensus.

Chapter 2

Coding as Organising: Code Forking and Generativity in the Bitcoin Community[5]

[5] Authors contributed equally, co-authored with Jonas Valbjørn Andersen of the IT University of Copenhagen. This paper will be submitted to the *Journal for the Association of Information Systems*' Special Issue on the Opportunities and Challenges of Blockchain Technology in March 2018.

Abstract

Digital infrastructures play an increasingly central role in shaping existing organisations and creating new ones. Research on digital infrastructure has rested on the assumption that infrastructures are developed to support pre-existing organised activities. However, with the rise of new digital infrastructures supporting open source projects and blockchain communities such as Bitcoin, digital infrastructures may also increasingly play a role in organising; that is, they have technical characteristics that give rise to new patterns of organising. Specifically, forking of the underlying source code and subsequent community adoption is observed to trigger new patterns of organising.

In order to explore and develop this concept, this paper investigates code forking in the distributed digital community of Bitcoin, an Open Source development. Our study examines how code itself plays a role in infrastructural evolution, and how the code changes that result create new patterns of organising, namely "speciation" through hard forks, "adaptation" through development forks, and "variation" through pseudo-forks. These forks are illustrated, analysed and discussed for deeper understanding of their role(s) in organising.

Keywords: Bitcoin, Blockchain, Online communities, Digital infrastructure, code forking

Introduction

The Bitcoin community belongs to a new breed of organisation: without offices, managers, contracts, policies or payrolls, and without strategies, charters or business plans, these organisations are fluid and digital in nature (Barrett, Oborn, & Orlikowski, 2016). In this particular case, an organisation emerged around a digital infrastructure, known as the Blockchain, and was shaped by the online activities of a community of distributed individuals, known as an Open Source (OS) community.

Interest in the Blockchain has grown in recent years; where once it was largely known for its role in automating transactions made using the cryptocurrency Bitcoin, it is today being developed for other purposes, including the transfer of other kinds of assets, and for recordkeeping (Morisse & Ingram, 2016). The original Bitcoin Blockchain, however, was not built to support these kinds of individual or organisational aims. Although its founder(s), pseudonymous Satoshi Nakamoto, discussed in a white paper how it might revolutionise the finance industry, it was not developed by an organisation with the intention of changing the industry, merely of showing how this might be done (Nakamoto, 2008). Moreover, its founder(s) withdrew from the development of the project at a very early stage—leaving a new community to form around it. As the infrastructure pre-dated the community, it drove how the community developed and was organised.

Evolution of the infrastructure was decided by community members' adoption of pieces of code. However, they could not use the infrastructure for anything other than its original sets of functions without changing it considerably, and these changes were constrained by elements of the infrastructure's source code. This constraining function of code has not been as visible in infrastructures that have previously been studied (Iannacci, 2010; Kuk & Janssen, 2013).

The underlying source code puts limits on what members of the community can do. For instance, the entry of a new transaction onto the blockchain by a miner is communicated to the other miners in the network in order to for them to verify that it is legitimate and consistent with previous entries (and does not come from a fake account, for instance). In this way, the Bitcoin infrastructure is kept up to date, and its contents are verified and stored by other miners. The software is designed so that transactions can only be added onto the blockchain after verification by the rest of the actors, and cannot be removed once entered without changing

the entire blockchain.[6] The blockchain therefore becomes more-or-less unassailable. This position is secured by virtue of a part of the source code in the Blockchain protocol, which says that the version of the software, which includes the blockchain, held by the majority of miners is the "real" Blockchain (Nakamoto, 2008a; Taylor, 2013).

This code implementation prevents individual actors from changing the blockchain. However, it also has another effect: in order for large changes, known as code forks, to be made to the Blockchain, the majority of 'miners' (community members that process transactions) has to adopt them. When this occurs, those miners running the version that is in the minority are seen to be running a *de facto* alternative. That is, they are no longer running a compatible version of the infrastructure—neither the source code that they run nor the transactions entered into minority-held alternative blockchain will be recognised by the original source code. This is, however, only true when the versions are inconsistent with one another; more subtle implications apply when minor updates of the code or consistent code additions are involved.

In their seminal 1996 paper, Star and Ruhleder outline what scholars of digital infrastructures today consider to be a foundational understanding: infrastructure is something that "…becomes infrastructure in relation to *organised practices*" (1996, p.112, emphasis ours). Consequently, one of the explicit characteristics of infrastructure is that it relies on established organisational practices. This notion is echoed in studies of digital infrastructures; Henfridsson and Bygstad, citing Malhotra et al (2004) for instance, describe them as "…partner interface-directed information systems that enable an enterprise to process information collected from its supply chain partners so as to create new knowledge" (Henfridsson & Bygstad, 2013: 909). Indeed, this sentiment is expressed as one of the explicit assumptions underlying the study of infrastructures: "Infrastructure does not grow *de novo*; it wrestles the inertia of the installed [organising] base" (Star & Ruhleder, 1996: 113).

However, research on digital infrastructure has also highlighted the generative capacity of digital infrastructures to transform organisations (Hanseth & Aanestad, 2003; Henfridsson & Bygstad, 2013). This notion of generativity in digital infrastructures suggests that embeddedness in an *a priori* organisational context and existing installed base is of diminishing importance to digital infrastructures, to a point where a pre-existing organisation might not be necessary for subsequent organising by online communities or others. Instead, organising (notably by online communities) may emerge independently or in the periphery of a pre-existing organisation. As flexible digital infrastructures and organisation co-evolve (Tilson et

[6] Although there is some discussion around how much control is required to retrospectively change the blockchain, see e.g. Eyal, I. and Sirer, E.G., 2014, March. Majority is not enough: Bitcoin mining is vulnerable. In *International Conference on Financial Cryptography and Data Security* (pp. 436-454). Springer Berlin Heidelberg.

al., 2010), the question therefore becomes one of how organising takes place in online communities based on digital infrastructures without a pre-existing organisation. As members of OS communities, a subset of online community, are the most in command of the digital infrastructures that mould their community, they make an ideal community for study. This paper therefore seeks to answer the research question:

> What is the role of code forking in digital infrastructures in the organisation of OS communities?

We address this question through a multi-method, longitudinal case study of the emergence and evolution of the Bitcoin community from the Blockchain infrastructure over the course of six years. The Bitcoin Blockchain, while an infrastructure, does not have an organisational legacy. Instead, the infrastructure was created in isolation: by an anonymous individual or group of individuals who later severed ties with the project. As such, Bitcoin does not have an *ex ante* organising base, as it was severed from whatever organisational base it once had. Instead, organising emerged from and around the infrastructure as it evolved. For the time being, the Bitcoin Blockchain is an extreme and isolated case. However, it is instructive in providing insight into the larger phenomena of organising associated with digital infrastructures (Siggelkow, 2007), especially as digital infrastructures gain significance within both existing and emerging organisations. It is worth noting that the Bitcoin Blockchain has inspired a variety of other Blockchain-based infrastructures (e.g. Ethereum, hyperledger, etc.), but for the sake of being able to draw clear empirical boundaries we focus only on the Bitcoin Blockchain. This research may nevertheless have implications for understanding these second (and third) generation(s) of digital infrastructures.

This paper is structured as follows. First, we examine the existing literature on digital infrastructures to identify organising principles. Based on our review of existing literature, we propose and substantiate how coding, and specifically code forking, acts as a mode of organising. Thereafter we present the case background and research design, before showing how code forking in the blockchain infrastructure led to organisational change in the Bitcoin community. Finally, our research findings and their implications for –organising among online communities are discussed.

Organising in Digital Infrastructures

Star and Ruhleder (1996) observe in their seminal work on infrastructures that infrastructures are most apparent when they fail. This ability of infrastructures to recede into the background highlights how they emerge: someone does something in relation to someone (or something) else, thereby mobilising a collection of artefacts, which we consider emergent digital infrastructure, e.g. a customer buys goods from a vendor via a card payment infrastructure, colleagues exchanging emails etc. Infrastructure therefore relies on some form of organised activity by an group of actors in order to be considered an infrastructure: "Analytically, infrastructure appears only as a relational property, not as a thing stripped of use" (Star & Ruhleder, 1996: 113).

Consequently, digital infrastructures have been described as a as the layer of code upon which both platforms and applications are built (Tilson et al., 2010). Infrastructures entail the employment of technology to facilitate existing organisational practices (Vaast & Walsham, 2009). Henfridsson and Bygstad (2013) observe that infrastructure is often used as an independent variable to support other organisational processes and aims, for instance knowledge creation (Malhotra et al., 2004), performance gains (Rai, Patnayakuni, & Seth, 2006) or outsourcing processes (Tanriverdi, Konana, & Ge, 2007). Such organising practices are a foundational element of infrastructure: an infrastructure is fundamentally something, which supports some organised relational practice through which it is actualised (Star, 1999). The focus of previous theorising around digital infrastructure has emphasised how organisational structures (Henfridsson & Bygstad, 2013) and boundary objects (Eaton et al., 2015) determine infrastructure development.

Digital infrastructures have, moreover, been said to be incredibly flexible and generative (Yoo et al., 2012). While limits to this generativity from outside, for instance through control points (Herzhoff et al., 2010) or boundary objects (Eaton et al., 2015), the role of the digital infrastructure in limiting its own generativity has not been explored.

This is despite the existence of a broader in the information systems literature for research that interrogates the role of digital artefacts in their own use and perpetuation (Leonardi, 2013; Orlikowski & Robey, 1991), especially in organisations and organising processes. However, in the context of infrastructures, this call has remained unanswered. This may largely be because it is hard to conceive of the development of an infrastructure without an overarching set of organisational aims in mind.

Existing Views on Infrastructure Organising

Digital infrastructures have been argued to possess an "…overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain, 2006: 1980). The result is emergent (Edwards, Jackson, Bowker, & Knobel, 2007) and even 'accidental' progress, or innovation (Austin, Devin, & Sullivan, 2011). However, previous studies have not explored the mechanisms that explain how digital infrastructures, apart from those wholly controlled by single organisations (Ciborra, 2000; Eaton et al., 2015), lead to this progression or innovation through organising. This begs the question of whether digital infrastructures, in an age of increased automation and digital ubiquity, do indeed carry the seeds of their own evolution.

Received literature on digital infrastructure represents at least four distinct principles representing different views of how organised social practices give rise to digital infrastructures; namely through adaptation, inscription, interaction, and management choice.

First, adaptation views see digital infrastructure evolution as a result of the efforts of distributed human actors to adapt to their environment and to other actors (Braa et al., 2007; Hanseth, Jacucci, Grisot, & Aanestad, 2006). Adaptation views build on developments of complexity theory (Holland, 1995; Mol & Law, 2002). For example, Hanseth & Lyytinen (2010) propose a theory of how digital infrastructure design can account for the adaptability of distributed actors, and Nan (2011) explores how the use of distributed digital technology emerges as adaptations between users, technology and tasks.

Second, inscription views describe how infrastructures evolve as human actors translate and inscribe their interests into assemblages of technological components, thereby seeing infrastructures as evolving networks of human and non-human actors (Aanestad & Jensen, 2011; Hanseth & Monteiro, 1997; Yoo et al., 2005). Building on actor network theory (Callon, 1986; Latour, 1987), inscription views emphasise the relationship between human actors and technology in translating and inscribing behaviour in structural terms and see infrastructure evolution as changes to a set of relations between humans and technology as human actors mobilise resources to support some more or less organised action. For example, Eaton et al. (Eaton et al., 2015) describe how the tuning of boundary resources by a network of distributed human actors affect digital infrastructure evolution.

Third, interaction views argue based on the premise that an infrastructure's evolution should be seen as a process of continuous interaction between its users and stakeholders as they engage in sensemaking around an organised activity. Drawing from theories of collective learning and work practices (Lave & Wenger, 1991; Wenger, 2000), interaction views see infrastructure evolution as a result of

interactions within a given community-of-practice resulting in the formation of socio-technical relations (Pipek & Wulf, 2009; Star & Ruhleder, 1996; Vaast & Walsham, 2009). For example, sustained participants in OS communities consistently engage in situated learning that both made conceptual contributions of advising others and practical contributions by improving the code (Fang & Neufeld, 2009).

Finally, management views emphasise the role of management decisions in facilitating infrastructure evolution. Infrastructure evolution is seen as a process by which managers initiate and implement changes to information technology infrastructure in order to align strategic IT capabilities and strategic objectives (Beckert, 1999; Child, 1997). For instance, Broadbent & Weill (1997) explain how managers through thorough understanding of the strategic context of their organisation can define maxims to determine the infrastructure capabilities they should implement to achieve their business objectives.

Table 7: Existing understandings of organising in digital infrastructures

Organising principle	Description	Theoretical foundation	Example references
Adaptation	Distributed actors adapt to their environment through changes in tasks, technology and relations	Complexity theory	Hanseth & Lyytinen (2010) Nan (2011)
Inscription	Existing organisational practices are inscribed in technological artefacts	Actor Network Theory	Aanestad & Jensen (2011) Eaton et al. (2015) Yoo et al. (2005)
Interaction	Interactions in a community of practice resulting in new socio-technical relations	Collective learning and communities-of-practice	Fang & Neufeld (2009) Pipek & Wulf (2009)
Choice	Choice of infrastructure governance and organising as a result of informed management decision	Strategic choice theory	Beckert (1999) Broadbent & Weill (1997) Child (1997)

The principles outlined in Table 7 share three main assumptions about infrastructure organising: first, that infrastructure-organisations are built upon pre-existing organised practices (Star & Ruhleder, 1996). Second, in the course of infrastructure evolution, human behaviour is inscribed into the technological components of the infrastructure (Hanseth & Monteiro, 1997), and third that changes to the infrastructure require coordination among heterogeneous and distributed human actors (Ciborra, 2000; Hanseth & Lyytinen, 2010).

However, these assumptions mean that existing conceptions of digital infrastructures do not fully account for the emergence of the Bitcoin infrastructure. Moreover, they fail to account for a situation in which human behaviour is constrained by the infrastructure itself, such that adoption becomes a key organising principle. In the following, we propose and substantiate an additional organising mechanism of digital infrastructures: adoption through code forking.

Coding as Organising

Infrastructures have been said to evolve based on common organising conventions, and rely on installed base inertia in adhering to shared standards (Edwards et al., 2007; Star & Ruhleder, 1996). One of the areas in which maintenance and changes in digital infrastructures are visible is at the level of the source code which comprises the infrastructure (Nyman & Lindman, 2013). Indeed, source code is the very material that dictates how the infrastructure works, including the rules whereby platforms, applications and other modules can connect with it.

As research attention turns to the importance of digital materiality in organising (Gherardi, 2009; Leonardi, 2011; Orlikowski, 2007), the practice of coding of digital infrastructures is increasingly deserving of consideration when it comes to its role in organising. Indeed, although some conceptions of materiality consider only those things with tactile embodiment as "material" (Orlikowski, 2007), others argue that all "objects, sites, and bodies" (Ashcraft et al., 2009: 2) that have significance should be considered in organising (Leonardi, 2010). Without engaging in the debate around whether digital code should be considered material, we nevertheless propose that insofar as such code affects social and organising processes it should be considered as a mechanism of digital infrastructure organising.

The complexity of digital infrastructures at large-scale goes beyond that of traditional systems design (Hanseth & Lyytinen, 2010; Henfridsson & Bygstad, 2013; Tilson et al., 2010; Yoo et al., 2010). Due to the scale and complexity of digital infrastructures, distributed forms of control are often the only way to organise digital infrastructure (Hanseth & Lyytinen, 2010; Star & Ruhleder, 1996). In general, the sheer task of maintaining the infrastructure requires more resources and knowledge than a single person or organisation possesses, leading to a distribution of both control and decision-making structures (Yoo et al., 2010). This means that digital infrastructure effectively become 'doubly distributed' networks in which "…both organizational and technological controls are distributed among heterogeneous actors and artefacts " (Yoo et al., 2008: 1).

The heterogeneity and programmability of digital technologies have led to new forms of generative and distributed organisations, where digital technologies and

organising meld together (Dhanarag & Parkhe, 2006; Yoo et al., 2008). In other words, the creation of organisational form takes place through the production of computer code. Digital code has dynamic (Aho & Hopcroft, 1974; Kitagaki & Hikita, 2007) and even agentic capabilities (Andersen, Lindberg, Lindgren, & Selander, 2016). The importance of digital code for infrastructure organising therefore lies not only in how it represents organisational practices, but also in how it plays an active role in organising.

Building on existing research on digital infrastructure (Hanseth & Lyytinen, 2010; Henfridsson & Bygstad, 2013; Tilson et al., 2010) we therefore propose that digital infrastructures, through generative and emergent changes to digital code, have the potential to foster new forms of organising. This is particularly through the adoption of code, but a necessary pre-condition for the adoption of new code is its development, including through forking. Next, we move on to discuss how code, and code forking operates as an organising process.

Code Forking as Organising

The most well-understood communities of source code developers are OS developers. These developers initiate and organise themselves around the desire to find a solution to a particular problem, or 'shared itch' (Raymond, 1999), and produce source code in order to do so. In these communities, both changing and maintaining the source code (infrastructure) is done jointly, and both bugs within the code, and threats to the infrastructure (for instance from hacking) are dealt with collectively by members of the community. Among such communities, changes to the underlying code are commonplace, and expected (Fang & Neufeld, 2009). Often there is consensus as to what should be changed or fine-tuned, and why. Such changes to the code are discussed among developers and contributors and, as such, visible in, for instance, online forums (Phang et al., 2014), although it may take negotiation to come to an agreement and some members of the community may be more active than others (Phang et al., 2015). These projects are run against the backdrop of an OS licence. Although there are many kinds of OS licence, they typically allow, at a minimum, the free re-use of code covered by that licence. As a result, splits from the original OS project cannot be prohibited, although are typically discouraged (Nyman, 2015).

Given the fact that maintenance of the infrastructure—and therefore its evolution—is shared, what happens when there is a disagreement about the future of the infrastructure from within the community? In non-distributed and proprietary settings, the problem is solved with reference to the organisation's hierarchy (Dahlander & Magnusson, 2005; Kartseva, Hulstijn, Gordijn, & Tan, 2010). How-

ever, in the case of an OS community, the answer is less simple: in general, members of the community try to come to a negotiated settlement (Nyman, 2015), but in exceptional cases some developers diverge in their opinions of the future of the project, and two (or more) inconsistent versions of a project are created.

These spin-outs are known as 'forks', and are defined as when "a part of a development community (or a third party not related to the project) starts a completely independent line of development based on the source code basis of the project" (Robles & González-Barahona, 2012: 3). These have been classified as having three types: code fragmentation, pseudo-forking, and code forking (Raymond, 1999). The first two types involve the distribution of the original code along new channels, but the resulting new distributions of the code are both compatible with the old version and benefit from future developments in the parent code (Nyman, 2015). However, a code fork is a complete change in the underlying code such that the new version of the code and the old version of the code are forward incompatible. In previous studies of forks, only one kind of fork has been observed. However, where source code is used to support infrastructure, both forward and backward compatibility are at issue. This is because an infrastructure can contain a historical record in a way that other OS projects may not need to. We therefore distinguish between these two kinds of forks; namely the "soft" fork, which is only forward-incompatible, and the "hard" fork, which creates a fork that is both forward and backward incompatible.

These forks are typically frowned upon by the OS community, largely because of the impact on both community and individual developers' reputations (Nyman, 2015; Weber, 2004) and because multiple, incompatible versions of a software can discourage related future developments (Meeker, 2008; Nyman, 2015). Consequently, within and beyond OS communities, forks in the source code are a key visible element in the instantiation of digital infrastructure organisation. As such, the notion of code forking provides a theoretical lens through which digital infrastructure evolution and organising can be studied.

What follows is a description of how we studied forking through a longitudinal research design.

Research Design

In order to answer the research question of how digital infrastructures evolve new forms of organising in OS communities, we conducted a longitudinal, multi-method (Venkatesh, Brown, & Bala, 2013) study of an emerging digital infrastructure covering a period of six years. In the following section, we first discuss our case selection and background before explicating data collection and analysis.

Our choice of case was driven by the need to meet four basic requirements: first, the infrastructure had to be an extreme case of where code lead directly to the emergence of organisational outcomes. Second, we had to be able to identify distinct instances of forking and adoption. Third, the infrastructure selected as case setting needed a history spanning over a longer period of time allowing us to study its evolution in both detail and scale. Finally, the infrastructure should have good records of both code forking and organising practices to allow us to analyse the implications of code forking on organising.

To our knowledge, there is currently only one infrastructure that meets these requirements: the Bitcoin Blockchain. It uses coding as organising, is relatively long lived, and has good digital trace records. Although the OS software has been re-used to create new infrastructures (e.g. Ethereum, Ripple), these next generation applications are still emergent and, as cases, are still ongoing and therefore trickier to study (Yin, 2003).Moreover, as an infrastructure with a sizeable and distributed user and supporter base, forum data provides good records of both when forks occurred (or could have occurred) and the underlying social contexts of these forks.

Data Collection and Analysis

Our aims with this research were 1) to identify and understand code forking events of significance to the organisation of the Bitcoin community as well as their broader context, and 2) to establish the role of code forking on the organisation of the Bitcoin community. Our data collection and analysis therefore took into account these two objectives, and are summarised in Table 6.

Overall, our methods were grounded in inductive reasoning and rested on the use of three sources of data: a series of ten interviews with Bitcoin entrepreneurs, digital trace data from the Bitcoin online community, and extensive documentation and. Our primary data source was forum data, and our computational analysis was triangulated against interview data and documentation. This was in order to 1) imbue our computational findings with context, as provided by interviews (Gaskin, Berente, Lyttinen, & Yoo, 2014) , and 2) to ensure the veracity of our findings.

Table 8: Overview of data collection and analysis

Data Source	Description	Analytical Techniques	Research Outcome
Digital traces	314 551 digital trace records of interactions collected from the bitcointalk.org community over a six-year period, including records referring to the Bitcoin source code as well as organisational changes	Latent Dirichlet Allocation (LDA), the results of which were coded to identify the main forking events that occurred, and the context in which they occurred	Identification and characterisation of organisational changes during each forking event
Interviews	10 formal, semi-structured interviews recorded and transcribed verbatim. The interviews focussed on key events in the Bitcoin community (forks, regulatory changes, stigma), as well as on the interviewees' understandings of the community and infrastructure's strengths and weaknesses	We used open and axial coding to produce analytical memos (Miles & Huberman, 1994) around the significant code forks, understand the background of the community, and highlight major associated events. This enabled us to verify findings in the primary data source, namely the forum data.	Identification of a sequence of significant events in which the Bitcoin source code was forked, including the type of forking for each event.
Documents	56 Press articles 71 Blog posts on topics related to forks and other conflicts (e.g. political ideologies) in the community from other sites (e.g. Bitcoinfoundation.org, Coindesk.com, Techcrunch.com, medium.com)		Identification of environmental conditions and important periods in the history of the Bitcoin community

We collected the digital trace records (Hedman, Srinivisan, & Lindgren, 2013; Howison, Wiggins, & Crowston, 2011) of community interactions across 314 551 interactions scraped from the Bitcoin forum bitcointalk.org covering a period from October 2010 to June 2016. Bitcointalk.org is a forum dedicated to discussions around Bitcoin, primarily in English. It is among the most prominent forums used by Bitcoin enthusiasts. However, unlike mainstream forums like Reddit.com, it is often used specifically by Bitcoin professionals meaning that interactions on Bitcointalk.org are particularly linked to the development of the Bitcoin code base. Furthermore, it contains sections that are both general and specific in nature; for instance, threads around the technicalities of the Blockchain and mining, as well as more discussions of a more organisational nature. We opted to examine forum data rather than a code repository like Github as the motivations and context of

technological change, as well as the resulting organisational practices, are better reflected in this kind of fine-grained semantic data.

We began by analysing forum data from the Bitcoin community across five phases. Each period was analysed separately using computational techniques on digital trace data (Hedman et al., 2013; Howison et al., 2011) to generate open codes for each time interval, analogous to what is done in manual coding (Glaser & Strauss, 1999). The collected digital trace data was divided up into five phases: October 2010-December 2011 (57 220 interactions), January-December 2012 (84 100 interactions), January 2014-July 2015 (122 409 interactions), August-September 2015 (25 431 interactions), and October 2015-June 2016 (25 379 interactions). We began a first level coding of the data using the computational natural language processing technique Latent Dirichlet allocation (LDA) implemented in the open source statistical software R (Blei, Ng, & Jordan, 2003). LDA is a generative topic model that reveals patterns in a set of documents by extracting unobserved groupings (latent themes) based on semantic similarities between different parts of the data (Sievert & Shirley, 2014). LDA discovers latent themes within a collection of documents by sampling a topic for each word at every iteration of the algorithm and ranking words based on their relevance to each topic, which therefore has a unique distribution over words that can be compared using cosine similarity measures (Chuang, Manning, & Heer, 2012).

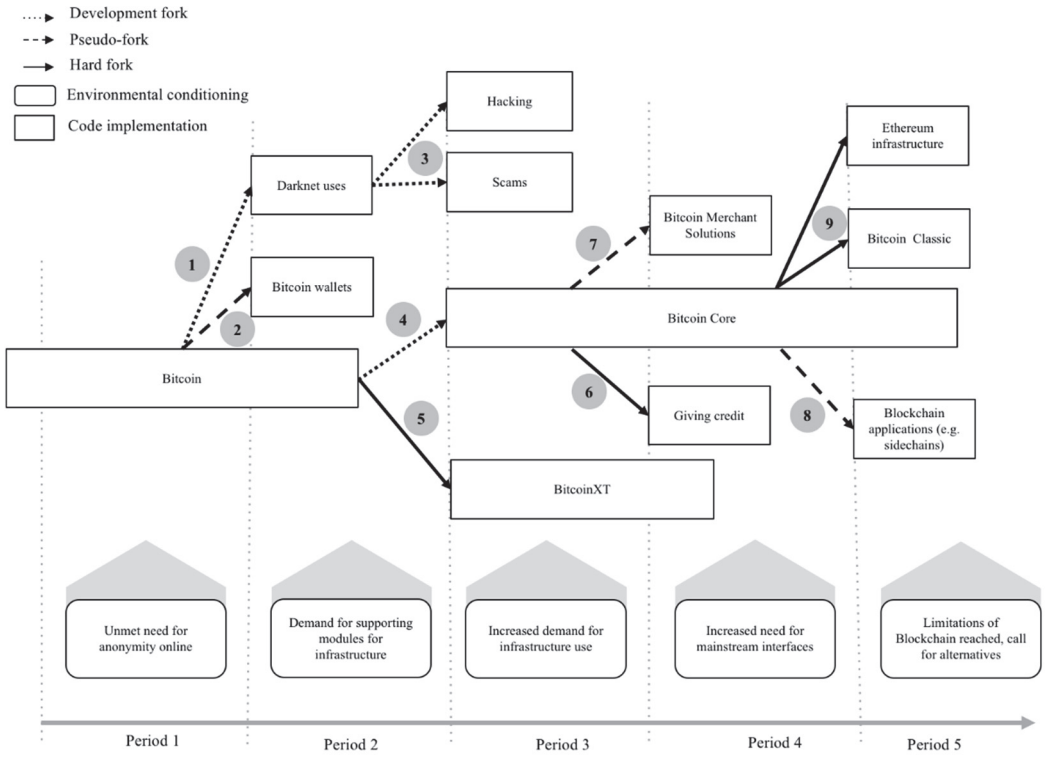
Analysing semantic clusters of terms by topic allowed us to discern combinations of topics under discussion by users related to each forking event. This period-by period clustering was then compared with analytical memos (Miles & Huberman, 1994) generated through an analysis of 10 interviews and a number of online documents to ensure its validity. These additional sources were necessary because of the risk of losing context when conducting computational analyses (Gaskin et al., 2014). Thus, while forums provided the primary data (and the main analytical findings), analytical memos based on other data sources provided vital context. These analytical memos were created after open and axial coding of the interviews and documents described in Table 2 (Glaser & Strauss, 1999). During coding, we looked for important forking events and the type of forking involved, as well as for the social environmental contexts co that influenced the Bitcoin community.

The three sources of data were combined to generate a thick longitudinal analysis of the organisational antecedents and outcomes of specific code forks in each period. Based on this analysis, we produced a thick description (Bechky, 2006) of the role of code forking, as a mechanism, in organising in the Bitcoin community.

Patterns of Coding as Organising in the Bitcoin Community

Our longitudinal analysis of the Bitcoin infrastructure and community revealed three distinct patterns by which the practice of developing the underlying source code was instrumental in shaping how not only the digital infrastructure but also in (self-)organising the online community. These patterns of potential organising become visible on the level of code forks, with adoption turning these potential changes into actual changes.

Figure 3: Forking in the Bitcoin infrastructure



What is interesting to note is that code forks occurred in response to the changing environmental conditions in which the infrastructure existed. This is consistent with existing understandings of infrastructure as including organisational practices and contexts, as well as the artefacts themselves (Star & Ruhleder, 1996). As this was a longitudinal study, we could examine not only when and why the code forking in the digital infrastructure evolved into potential new organisational forms, but also when new ideas were incorporated into the existing infrastructure through adoption. The three distinct forms of code forking i.e. development forks, pseudo-

forks and hard forks, their environmental conditions, and an overview of the sequence of forking events of importance to the online community are contained in Figure 3.

In the following, we analyse how each form of code-forking led to a specific pattern of organising. Inspired by terminology well-established in systems biology literature, we address how different types of organisation occurs in response to environmental stimuli (Zimmer & Emlen, 2013).We have called these patterns of organisation emergence 'speciation', 'variation' and 'adaptation'. Each pattern of pattern is illustrated through an empirical example and related to similar instances in order to discern the specific characteristics of each pattern.

Hard Forks as Organisational Speciation

The first pattern of coding as organising is driven by a hard fork to the underlying code; that is, a fork in the code that created a new infrastructure that is both forwards- and backwards- incompatible with the existing infrastructure. If the community adopts this 'forked' version of the code *en masse*, it will become the dominant infrastructure. In fact, one might even say that it becomes the infrastructure, while the previous versions of the code are discarded or held by a less influential minority. We will refer to this pattern as 'speciation', or the creation of a new species of infrastructure

A particularly illustrative example of a hard fork is that of the BitcoinXT (fork 5). In June 2015 two prominent developers of the Bitcoin source code suggested that the sustainability of the project was in jeopardy. In late 2015, Bitcoin transactions began to be delayed and a backlog of transactions grew. In other words, the infrastructure began to fail (Hearn, 2015). An infrastructural shift, known as BitcoinXT ("XT"), necessitating a change in the underlying source code was proposed as a solution. This proposed solution would entail increasing the size of each block in the blockchain from 1mb to 4mb:

> As Bitcoin has grown, so have the blocks. Reasonable traffic projections indicate that as Bitcoin spreads via word of mouth, we will reach the limit of the current system [with a 1mb block size] sometime next year, or by 2017 at the absolute latest. And another bubble or press cycle could push us over the limit before even that. The result might not be pretty. So it is now time to raise the [block size] limit, or remove it entirely. (Mike Hearn, Aug 15, 2015)

Increasing the block size would reduce the number of miners able to run the software (owing to issues around processing power), but would increase Bitcoin's transaction handling capacity. Opponents of this change labelled the original ver-

sion of the infrastructure Bitcoin Core, and they argued that, among other things, XT was untried and may not scale well (with which XT proponents disagreed). They also argued that this change would make the project more centralised, putting more power in the hands of fewer miners—who could make more drastic changes in the future. This back-and-forth shows how political beliefs affected how code changes were perceived, affecting willingness to adopt. In essence, they agreed with the need to do something, but argued that the technical shift to XT would change the social practices whereby the infrastructure operated, namely by centralising control of the source code. OS communities often identify strongly, so controversial attempts to change it are often taken personally (Ren et al., 2012):

> Bitcoin's own former lead dev, Gavin, and his henchman Hearn are in the process of sabotaging Bitcoin from the inside. You will hear about it when their XT Trojan horse deploys its payload, and attempts to force us all to join their altcoin at Bitcoin's expense. (July 9, 2015, 03:42:23 PM)

The rules for how a potential change to the root code of the Blockchain can occur are enshrined in the source code. In essence, minor changes that create compatible versions of the software are dealt easily, while major changes, like in this "fork", require active adoption. Only majority adoption of a change will mean that the root source code is changed. Participants in the network, whether miners or entrepreneurs running platforms on the Blockchain infrastructure, have to choose which version to run. Ultimately, the version that garnered the most support would become the "real" Blockchain.

The attempt to fork the Blockchain source code ultimately resulted in two forward- and backward-incompatible versions of the Blockchain: Miners did not adopt the XT version of the code in sufficient numbers to make it the dominant version of the Blockchain. Moreover, swathes of the Bitcoin community also boycotted entrepreneurs and users who switched over to XT. The changes to the source code were therefore not internalised, resulting in what would become what the community called a "hard fork" to the source code. Unlike a soft fork, wherein the new version of the infrastructure is compatible with those running the old version of the software, a hard fork would entail those running old versions of the software being unable to read/recognise changes in the new version.

This hard fork to the Blockchain was prompted by environmental changes around the infrastructure, to which a response was needed. The source code governed what changes could and could not be made, and the fork itself became a reality through two changes. First, through code changes to the infrastructure, and second, through adoption. Substantial adoption above a certain threshold was needed for the material, code-level changes in order for the new version to be con-

sidered the "real" infrastructure, especially as the changed source code was prospectively and retrospectively inconsistent with the previous source code.

This hard fork created two 'species' of infrastructure; the original Blockchain and the alternative Blockchain that resulted from a hard fork that substantially altered the underlying source code so much that it made the two pieces of infrastructure inconsistent with one another. However, this hard fork was just one instantiation of evolution. In order to test for the generalisability of a hard fork leading to speciation in infrastructure evolution, as well as to test for other possible mechanism of digital-first infrastructure evolution, we expanded our observations and inductive analysis to span 6 years. At the time of data collection, this was the lifetime of the Bitcointalk.org forum dedicated to the infrastructure and the community.

Other instances of speciation through hard forks include fork 7 in which some members of the Bitcoin community saw the future of the infrastructure as being as a part of the existing financial system, not as a parallel currency system. One of the sticking points in this area was the fact that more Bitcoins could not be created at will; the Bitcoin source code dictated that they could only be created through mining, and at a decreasing rate up to a maximum number. However, the mainstream financial system relies heavily on credit. In early 2013, this was seen as both a merit of the Blockchain system and a possible stumbling block to greater integration of the mainstream and Bitcoin financial systems. Altering the system such that it could issue credit would have required a substantial change to the Blockchain system. Unlike the XT change, the environmental pressure exerted in favour of this possibility was not sufficient to drive the hard fork it would take to make it a reality. As such, it was a hypothetical hard fork that was never adopted at the level required to become a new form of organising.

The final hard fork (fork 8) revolved around alternative uses of Blockchain-like infrastructures other than for Bitcoin, and is driven at least partly by the limitations the Blockchain was seen to have at that point. Users point both to the fact that Bitcoin transactions are slow (as was the case with XT), and to the fact that the Blockchain in its then-incarnation did not easily allow for the storage of other kinds of information, or the execution of smart contracts. This results in several major hard forks, the most-discussed of these are Bitcoin Classic and Ethereum. Bitcoin Classic, like XT before it, proposes to increase the size of the Blockchain in order to facilitate a larger number of transactions more quickly, while Ethereum is developed to facilitate the use of the Blockchain technology for other kinds of applications, for instance smart contracts, and has effectively resulted in the emergence of a separate OS community. This community is both operationally and ideologically distinct from the parent community.

These three different hard forks represent substantial organisational changes. In the case of this distributed infrastructure, the code forking mechanisms around adoption require that substantial changes be backed by substantial adoption. In essence, the code supports and reinforces the status quo, while changes to it would require significant resources and mobilisation on the part of would-be forkers. The organising mechanisms at work here could pan out in one of two ways: for the hard fork to be absorbed by the infrastructure would require adoption by users on a large scale. There is therefore a social element to an otherwise technical evolution; the combination of the two are what leads to internal evolution, or what we later call "variation".

The exact implications of organising depend on the precise changes made to the underlying source code, but in the case of hard forks, change necessarily involve completely new organisational structures. In the case of a shift to XT, for instance, the technical centralisation of the infrastructure (by making mining harder and therefore raising barriers to entry) would put control over the infrastructure into the hands of fewer—meaning that future decision making would be controlled by a sub-set of the existing (or a new) community. Moreover, as a larger block size would facilitate wider use of the Blockchain and make it a competitor for the likes of Visa and Mastercard, its mainstream appeal is likely to change the composition of the community for which Bitcoin has become known, partly through the change in control structures and partly through changing who has an interest in maintaining the infrastructure. Thus, this fork creates new organisational forms in the community: it changes power dynamics and thus future decision-making, as well as the composition of those in power.

Thus, the creation of a whole new organisation—with new practices and meanings—requires both a change in source code and a substantial amount of adoption. Speciation is therefore an instance of infrastructure evolution framed according to code-level changes, and implemented at the level of user adoption.

Development Forks as Organisational Adaptation

Variations on the level of code use were not the only forms of organisation driven by forking of the underlying source code. Adaptation, or developments that added to the underlying source code, were also important and influential drivers of community organising. Development forks built upon the underlying source code to enable new technical functions which, in turn, led to adaptation in the community through a combination of code and practice changes.

One of the most extensive, and common, adaptations revolved around how the infrastructure led to the development of entrepreneurship-focused adaptations

of Bitcoin (fork 2). These adaptations involved the development of code that built upon the existing source code without introducing incompatible elements. Some examples of this include the development of wallets to hold Bitcoin currency, and analytical tools that conduct analytics on the contents of the underlying blockchain infrastructure.

As these developments built upon the existing source code, they enabled new code uses; most notably entrepreneurship through the creation of start-ups and corporate ventures. However, they also incorporated the organising elements inherent in the underlying source code. One member of the community expresses how new adaptations were accepted by the community under certain conditions:

> Please understand that I have great respect for the work you've done. Your service is very well constructed and well-loved for good reason. While some of the things I've brought up might be improved with some tweaks here and there, much of it is simply the structural consequences of centralized services, trusted parties, web clients, etc…I don't think our community should take any actions which promote centralization or consolidation due to systemic risk if nothing else… I don't believe it should promote your wallet service either. (December 03, 2012, 03:02:53 PM)

But entrepreneurship did not just extend to services that catered to the existing community. Instead, some of the adaptations facilitated by the infrastructure allowed the infrastructure to interface with other infrastructures, enabling inter-organisational linkages. One example is that of a Point-of-Sale (PoS) adaptation (fork 6), which built both upon the underlying infrastructure and on other adaptations to extend the usefulness of the infrastructure:

> We have released an update of our Pos [Point-of-Sale] software witch includes a module to connect and process payments trough Bitcoin-Qt wallet. So with this update, more than 3000 local busineses over the world who now are using Sysme Pos as point of sale software can have the tool to accept Bitcoins We hope that this will encourage them to accept Bitcoin as payment so this this project can make a step further. (June 05, 2013, 09:53:11 PM)

Such an addition was not only useful on the level of use, it also served to bring more stakeholders in when it came to supporting and engaging with the infrastructure. While the creation of entirely new adaptations led to the creation of new child organisations, adaptations that led to linkages with existing organisations had different organisational implications. They facilitated the transfer of some of the infrastructure's organising practices, in whole or in part, to other hitherto unaffected organisations.

Among the adaptations that built upon the infrastructure are those that would allow, in an indirect way, the infrastructure to perform additional functions. While

the Blockchain's original architecture was intended as a proof-of-concept for the transfer of a currency, one adaptation allowed for the transfer and maintenance of a centralised database of something other than that currency (fork 9). In an adaptation known as a sidechain, developers built upon the Blockchain to allow for an object-agnostic transfer which interfaced with the Blockchain:

> The paper proposes two-way pegged sidechains as an extension mechanism for Bitcoin. The idea is that coins would be able to move from the Blockchain, to a sidechain, and then back again in a trustless way. This would allow sidechains to implement properties that are not feasible to implement on Bitcoin itself, while preserving the total number of Bitcoins. (September 10, 2015, 03:44:19 PM)

Though it represents a drastic development, this fork was still consistent with the underlying source code. This meant that, like in forks 2 and 6, the new organisation that formed around the adaptation also relied on elements of the infrastructure's coded-in organising practices in order to function. Thus, organisational adaptation was enabled (and constrained) by source code, through development forks. These development forks added to the existing organisation by attracting new users to the community, and by making the infrastructure itself able to support more things—thus changing its character on the code level.

Pseudo-Forks as Organisational Variation

One of the most compelling patterns of organising that emerged from our longitudinal examination was how the flexibility of the Blockchain source code not only drove substantial changes in the underlying source code, but also permitted organisational variation when the environment encouraged them. These instances of variation are visible in forks 1, 3 and 4, with the first two relating largely to the use of Bitcoin for illicit purposes, and the third related to the identification of the existing Blockchain as 'Core'.

During the early stages of the evolution of Bitcoin in 2011 and 2012 (forks 1 and 3), many different kinds of users saw the new infrastructure as a potential for new ways of conducting transactions outside the established financial system. These forks, while seemingly something out of the ordinary do not entail any underlying code change. They are therefore called 'pseudo forks' and entail a variation in the patterns of code use—but nevertheless ones that have organisational implications. These new use patterns attracted a number of people whom used the infrastructure to conduct illicit activities. As one user observes:

> …I saw many a lot of devious schemes to earn bitcoin. Just like HYIP, PONZI, Gambling, Bet etc. I am very afraid of RIBA. therefore, for guidance and assistance will be appretiated. Thanks (March 03, 2012, 12:38:21 AM)

This was made possible by the nature of the source code itself. Indeed, the qualities of decentralisation and semi-anonymity—seen as elements of building a new technical system based on trust in a system rather than individuals or institutions—paradoxically also gave users the possibility to use the system for transactions that many in the community considered to be unethical, including transactions involving drugs on the Darknet,[7] and Bitcoin-denominated scams:

> Of course, bitcoin is not the problem. People who misuse the bitcoin and abuse is are the ones who are the problem. If terorrist are using bitcoin, not really nice of them to shed bitcoin in a bad light. (November 24, 2015, 02:36:19)

Another pattern of variation occurred when the Blockchain began to experience difficulties processing transactions: community members began discussing alternatives and changes to Blockchain to deal with these transaction lags (fork 4). Defenders of the existing infrastructure, including its existing coded-in form, began to emphasise the organisational implications of the existing infrastructure. Moreover, they labelled the existing infrastructure 'Core' in response to attempts to change the source code. Much like the variations in practice that use of the infrastructure for illicit transactions, this kind of fork is an instance of practice-level variation on how the infrastructure is used:

> The code which powers the Bitcoin network can be found here: https://github.com/bitcoin/bitcoin. This code has evolved as long as Bitcoin has been around. But the debate over the block size limit and how to manage it has caused some of the best-known developers to set up another client for bitcoin, here: https://github.com/bitcoinxt/bitcoinxt... The former is now referred to as "Bitcoin Core", and the latter "Bitcoin XT". … From the XT github README: "Bitcoin XT is more experimental than Bitcoin Core, and has a strong emphasis on supporting the needs of app developers and merchants. By running it you not only provide additional services to the network but help build confidence in the implementations, contributing towards consensus for inclusion in a future version of Bitcoin Core. (May 31, 2015, 05:28:36 PM)

These new patterns of code use arose both in response to the possibilities that the infrastructure presented, as well as the environment in which both actors and the

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[7] The most prominent case is that of Silk Road, an infamous online drug market that makes extensive use of the cryptocurrency Bitcoin.

community found themselves. In this case, organisational structures are changed through the proliferation of multiple ideologies, and the polarisation of certain practices within the community. Moreover, these practices may attract additional community members, affecting how the community interacts.

Source code, through pseudo-forks, therefore led to organisational variation. While interpretation and narrative changed the structure and dynamics of the organisation, the pre-existing code limited (and enabled) the possible interpretations. Having demonstrated how code forks enable and constrain organising, and the subsequent role of use/code adoption, we turn now to discussing these findings and their implications.

Discussion

Code forking involves both changes to the source code itself, and to the interpretation and use of source code for new purposes. Our findings show that different variations in these two parameters lead to different organisational outcomes. The configurations of changes to source code and code use amount to distinct patterns of organising using digital code. The following discusses each of the patterns of coding as organising that emerged through code forking and adoption practices.

Speciation is the process by which new organisational structures emerge from radical breaks in the source code. It requires both changes in the underlying code and in its adoption. For speciation to occur, code changes must replace existing source code base, whereby it creates a new infrastructure that is technically incompatible with the existing source code. This requires a complete reworking of the way in which the replacement code is produced, maintained, and applied in various contexts. This results in the creation of new organisational structures with new organising logics. In the case of Bitcoin, hard forks to BitcoinXT or credit based instantiations of the infrastructure would both have resulted in the introduction of a trusted third party acting as a middle man between users. This would effectively introduce a new organisational structure departing from the distributed, non-hierarchical organisation of the original infrastructure.

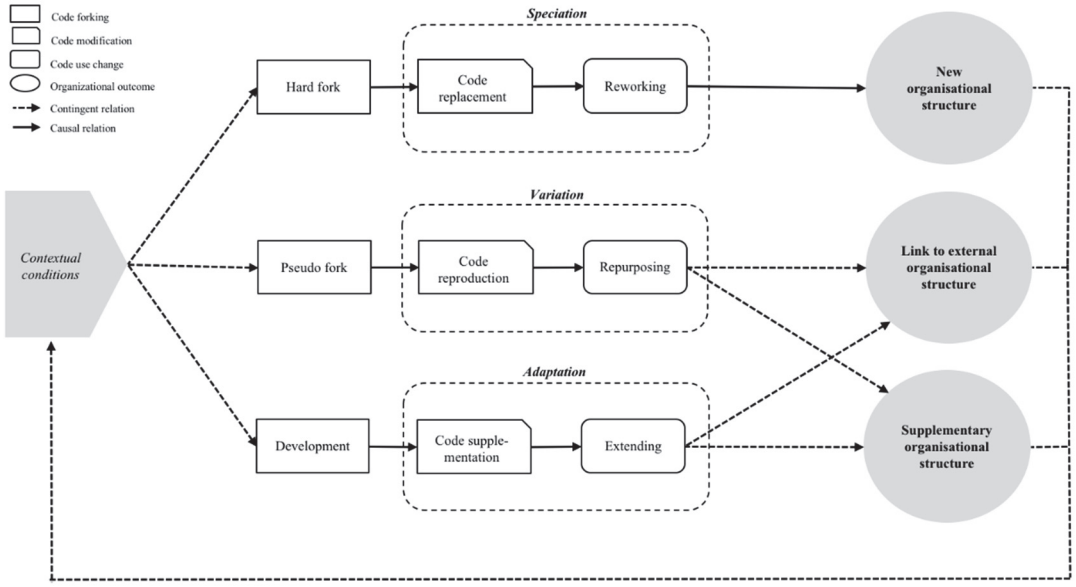
Adaptation refers to the process by which new supplementary organisational structures emerge by leveraging the infrastructure's existing source code. Adaptation can be seen to add to existing organisational structures by adding to the underlying code, and supplementing community membership. Adaptation involves code changes that rely upon the existing source code base and add to it, resulting in new use domains. The resulting supplementary organisational structures represent additions of new, yet compatible, organisational structures operating within the existing organising logic of the infrastructure. Examples of this in the Bitcoin infra-

structure include the introduction of new entrepreneurial products based on the core infrastructure whereby a new company is formed, which is reliant on the underlying infrastructure, and in some cases on other supplementary organisations.

Variation refers to the process by which changes in the area of application of existing code, or in interpretations of the existing code, can connect seemingly unrelated organisational structures to that of the infrastructure. Variations in the purpose of existing source code does not require any actual changes to the source code. Instead, the source code enables hitherto unexpected practices, which themselves have organisational implications. Examples from the Bitcoin case include fraudulent and illegitimate applications such as outright Ponzi schemes and gambling applications designed to bypass existing regulation to allow for higher stakes even in high-risk games.

The three types of code forking, how they manifest in code implementation and use as well as their antecedents and consequences are shown in Figure 4.

Figure 4: Patterns of coding as organising through code forking



The changes to source code and code use outlined in figure 2 are relational in nature and the maintenance of the community infrastructure necessitates constant interaction. Digital infrastructures, unlike platforms and applications, do not have strict boundaries and cannot be defined through a specific set of functions or modules (Tilson et al., 2010). Instead, their boundaries are defined through use practices, and their very existence relies on the continued practice of use, mainte-

nance and organising by a distributed group of users (Henfridsson & Bygstad, 2013).

The organisation of digital infrastructures takes place through a distributed process in which multiple users, through application of skilled knowledge and ongoing negotiation, contribute to the underlying infrastructure (Yoo et al., 2012). The range of competences necessary for successful institutional change to occur far exceeds the capabilities of a single actor (Yoo et al., 2012). These distributed actors contribute to this infrastructure through (hard, soft and pseudo) code changes, as well as new adoption practices (enabled and constrained by said code).

These changes are often hotly contested at the level of adoption and use. Indeed, the Bitcoin community, like other OS communities, discourages rogue changes through political ideology and community backlash (Dahlander & Magnusson, 2005; Kirsch, 1997). The OS nature of the code, however, means that on a technical level forking cannot be prevented—and thus the new patterns of organizing that result cannot be prevented either.

Previous research has emphasised the embeddedness of digital infrastructures in the organisations which initially design and later rely on them (Hanseth & Lyytinen, 2010; Henfridsson & Bygstad, 2013; Star & Ruhleder, 1996). This extant research sees organisational change as leading to infrastructural evolution, rather than vice versa. By showing how organising takes place through code forking in online communities without pre-existing organisational structure, we aim to contribute a better understanding of the role of the digital in organising in response to previous calls for research on the role of digital materiality (Leonardi, 2010).

While previous studies of infrastructural evolution have shown how infrastructure changes as a result of organisational changes, this empirical work shows the reverse: how the infrastructure—whether through change or existing composition—at the level of code leads to new organising practices. While user interpretations and adoption of the code is a vital part of this process, the possibilities open to the user are defined according to the code-level composition of the infrastructure. Fundamental changes, or what we have called speciation, therefore require changes to the fabric of the infrastructure through hard forks. The purpose of this study was to understand how this occurred.

Conclusion and Directions for Future Research

This paper provides an examination of the role of code in digital infrastructures that begins to build an understanding of how the act of coding digital infrastructure can lead to patterns of coding as organising.

This paper therefore contributes to extant research on digital infrastructure in the following ways. First, it identifies and conceptualises a new mode of organising around digital infrastructures where code, and forking, are a necessary precondition for changes in organisational structures, practices and composition. Second, based on literature on code development in OS communities, it proposes, substantiates and empirically identifies the concept of forking to show how, and when, code development practices combine into an organisational change mechanism. In so doing, it describes a vocabulary for describing the different patterns of coding as organising in online communities, and examines code forking as one way in which coding as organising occurs. Code forking leads to new organising tenets through variation, adaptation and speciation.

These patterns of coding as organising are most prominent among OS communities because members of the organisation themselves hold the skills, and tools, to enable code forks—a mechanism for organising in a digital-first world. While code-level, and thus organisational changes, are often hotly contested, both this paper and previous research in OS communities show that forking is sometimes unavoidable. As coding becomes more accessible and ubiquitous to non-engineering tasks, for instance through improved user interfaces and automation and more accessible programming languages, it is likely that the patterns of coding as organising will become more common, and thus more deserving of close study. We therefore encourage future examination of the role of code, and code forking in particular, in organisational change and organising.

Chapter 3

Taming Digital Flexibility: An Embeddedness Approach to Entrepreneurial Activity[8]

[8] Sole author. Submitted to *Research Policy's* Special Issue on Digitization of Innovation and Entrepreneurship.

Abstract

A rise in the use and development of digital infrastructures has affected organisations in unprecedented ways. Indeed, such infrastructures are typically treated as allowing for add-ons that are incredibly flexible and generative—allowing for new entrepreneurial firms to be similarly flexible and generative. However, we know from previous research into structural embeddedness that introducing a new process, product or service will mean that it will be affected by existing practices and beliefs in the field.

Drawing on existing theorising and empirical research around embeddedness, this paper examines the levels, and mechanisms, whereby embeddedness affects entrepreneurship using digital infrastructures. In so doing, it takes into account embeddedness' impetus towards inertia, as well as towards dynamism. Overall, it suggests that embeddedness limits the flexibility of entrepreneurial activity reliant on digital infrastructures, but points to a number of mechanisms whereby flexibility is encouraged through multi-level and nested embeddedness.

Keywords: entrepreneurship, digital infrastructures, generativity, flexibility, embeddedness

Introduction

Digital infrastructures represent the base upon which much of our increasingly digital world is being built. Indeed, they have been said to have encouraged wide participation in both service and product development and distribution, for instance through open source (Feller, Finnegan, Fitzgerald, & Hayes, 2008), the creation of new market conditions (Tilson et al., 2010) and by forming the base upon which flexible products and services can be built (Eaton et al., 2015; Yoo et al., 2012). Much has been made of the notion that these infrastructures can lead to high levels of flexibility, or what has also been called generativity (Tilson et al., 2010). For some, notably among lawyers, this apparent lack of limitations is cause for concern—as it could lead to infrastructures being used in ways their creators did not intend (e.g. Zittrain, 2006). However, others have heralded this flexibility as democratising, and responsible for lowering barriers to entry (Chesbrough, 2006).

Entrepreneurs are particularly keen on digital infrastructures insofar as they provide ready-made platforms for product and service sales (Eisenmann, Parker, & Van Alstyne, 2011), consumer marketing (Sawhney, Verona, & Prandelli, 2005) and development infrastructure (Tiwana et al., 2010). However, digital infrastructures are not built or maintained in isolation, and nor are the modular new ventures that are built upon them. Rather, infrastructures are thought of as being relational in nature; that is, embedded in human activities and reliant on them for actualisation (Star & Ruhleder, 1996). The extent to which digital infrastructures can be flexible and allow for unlimited entrepreneurship is therefore not just a product of their own characteristics, but also a product of the contexts in which they are embedded. Given recent interest in digital entrepreneurship as something distinct from other forms of entrepreneurship (Nambisan, 2016), understanding the limits to the generativity of digital infrastructures would further our understanding of digital entrepreneurship reliant on them.

Drawing on previous literature around the dynamics of embeddedness (Dacin, Ventresca, & Beal, 1999; Nee & Ingram, 1998) and information systems literature around digital infrastructures (Star & Ruhleder, 1996; Yoo et al., 2010), this paper develops a multi-level model of the effect of embeddedness on entrepreneurs' flexibility when relying on digital infrastructures. It proposes embeddedness as a mode of control that limits the flexibility of entrepreneurial activity reliant on digital infrastructures.

Extant research has pointed to the tension between the generative, or flexible, nature of infrastructural systems and the necessity of control over these systems (Ciborra, 2000; Eaton et al., 2015; Ghazawneh & Henfridsson, 2013). However, rather than interrogating how the relational character of digital infrastructures has led to *de facto* limitations, they have focused on agent-centric forms of control, such as the use of boundary objects (Ghazawneh & Henfridsson, 2013) and distributed tuning across boundaries (Eaton et al., 2015). Studies of convergence in digital infrastructure have hinted at some of the consequences of embeddedness for infrastructures (Herzhoff, 2014), but have not interrogated the mechanisms whereby this might lead to limitations on infrastructural flexibility, not least for entrepreneurs. Thus, while generativity is well-theorised and reasonably well understood, embeddedness is not.

This paper seeks to expand on this perspective with reference to existing research on digital infrastructures and embeddedness, asking the question:

> How can we understand the effect of embeddedness on the flexibility of entrepreneurship using digital infrastructures?

This paper is organised as follows: first, it examines extant literature on flexibility in digital infrastructures as it relates to entrepreneurship, zooming in on curbs on its flexibility. It then looks at structural embeddedness and mechanisms whereby this affects entrepreneurial activity, before then bringing the two together and developing a multi-level model of the effects of embeddedness on flexibility in entrepreneurial activity using digital infrastructure.

Embeddedness and Infrastructures

Entrepreneurship has been defined as the discovery, creation and exploitation of opportunities (Shane, 2000; Venkataraman, 1997). However, while much of the entrepreneurship literature has pinned the success or failure of a new venture on specific individual entrepreneurs or firms, there has been a backlash against this hero-worship of individuals (Dey & Steyaert, 2010; Garud & Karnøe, 2003). Instead, the literature has increasingly shown that entrepreneurs build upon the work of others (Van de Ven, 1993), whether the skills and knowledge of individuals in multiple domains (Karnøe, 1996), or the resources provided by the system in which they choose to operate (Morisse & Ingram, 2016; Van de Ven, 1993). Acknowledging the diverse resources, both social and technical, upon which entrepreneurs rely means taking an approach to entrepreneurship that is more social than often seen in the entrepreneurship literature. Indeed, it means closely examin-

ing how existing social and technological resources are recombined and transformed pursuant to the creation of a new venture (Garud & Karnøe, 2003; Schumpeter, 1934). Moreover, such an approach also means approaching technologies as more than mere "tools", but as constitutive of the entrepreneurial process (Scott & Orlikowski, 2014).

Digital infrastructures are a context within which more and more entrepreneurship has begun to be built. Consider, for instance, the entire entrepreneurial economy built upon the Apple Marketplace (Eaton et al., 2015) or the emergent economy being built upon blockchain infrastructures (Morisse & Ingram, 2016). Both contain underlying digital infrastructure that millions across the globe render infrastructural by virtue of continuing to use them. Millions of entrepreneurs build modular applications that rely on the infrastructure's code base, the network effects that it provides and its perceived flexibility (Nambisan, 2016; Yoo et al., 2010).

Indeed, it is this very fact of relying on the infrastructure for their activities that renders a digital code base infrastructural. Digital infrastructures, unlike platforms and applications, do not have strict boundaries and cannot be defined through a specific set of functions or modules (Tilson et al., 2010). Both the relational nature of infrastructures and their complexity and scale mean that they are not infrastructures until they become foundational, and their status as infrastructural is both reproduced, and embedded, by membership and conventions of practice (Star & Ruhleder, 1996). This reproduction and development is conducted by distributed actors drawn together by their shared use (Broadbent & Weill, 1998), and the contents and terms of this reproduction and development are negotiated and shared (Hanseth & Lyytinen, 2010). Thus, Star and Ruhleder (1996) argue that the seminal question is not *what* is an infrastructure, but *when*.

Infrastructures, for these reasons, are typically treated as being nearly infinitely flexible. This is both because they have a relational character and because one of the salient features of an infrastructure is that it allows modules to be built upon it. These modules rely on a pre-installed code base and limited pre-existing functionality. However, the modules need not interact with one another. Instead, they need only interact with the underlying digital infrastructure, in layers of modular architecture (Yoo et al., 2010). This means that nearly anything can be built upon a particular digital infrastructure, at least in principle, and the presence of other modules or functionalities does not preclude the development of new functions or modules (Edwards et al., 2007). This purely architectural approach to digital infrastructures has given rise to discussions around how, given this limitless potential for layered architecture, activity reliant on a digital infrastructure—typically called "evolution"—can be controlled, if at all.

Research into the limitations on this activity has largely followed this architectural approach. Research has delved into three ways in which infrastructure, through its architecture, can be controlled. These are summarised in Table 9.

Table 9: Existing conceptualisations of the constraints on digital infrastructures

Manner of control	Definition of constraint	Theoretical foundation(s)	Example references
Control points	The designing-in of nodes within the infrastructure itself that can be directly controlled	Design thinking, complexity theory	Broadbent & Weill 1997; Broadbent et al. 1999; Tilson et al. 2010; DeNardis 2012
Boundary resources (and objects)	The designing-in of modular elements that can be directly controlled, allowing for indirect control over the infrastructure	Innovation networks; boundary objects perspective	Ghazawneh & Henfridsson 2013; Eaton et al. 2015
Convergence	The process whereby infrastructures adopt similar standards, allowing for limited control	Process theory, phenomenology	Hanseth 2000; Herzhoff 2009; Herzhoff et al. 2010

The first of these is through designed-in control points. In this conception, power is thought be something that is designed into the infrastructure. In the case of the internet, for instance, DNS, IP addresses and domain names are points in the architecture upon which social actors such as ICANN or domain registrars can exert control (DeNardis, 2012; Mueller, 2010). Designed-in elements with technical functions may also serve as sites for political and economic debates as they are designed and implemented (Bonaccorsi & Rossi, 2003), and they may also allow for the co-evolution of business processes reliant upon the underlying infrastructure (Broadbent et al., 1999). What is key to note is that this direct control over elements of the infrastructure using designed-in elements requires that, in many cases, the desire to control the infrastructure at that point be anticipated by the infrastructure designers. If they are not anticipated, as is more often the case, they have to be added to the infrastructure piecemeal and *ex post*, as a new element. Moreover, direct control is exerted only at those points; control over other elements of the infrastructure is outside of the capabilities of this mode of control.

In contrast, studies of the use of boundary objects and boundary resources to exert control have been seen to allow actors indirect control over much of the infrastructure. A study of Apple iOs's service system, for instance, found that these boundary resources, which were continuously shaped and re-shaped, allows for

cascading actions of actions by the infrastructure (Eaton et al., 2015). Thus, those in control of the boundary resources also exerted indirect control over the manner in which the infrastructure developed, including the content and form of modules that were built upon it (Ghazawneh & Henfridsson, 2010).

Lastly, studies of convergence look at how similar standards, and the imperative to co-ordinate, have meant that infrastructures, like other digital artefacts, have converged on certain standards (Herzhoff, 2014). However, this form of control is very limited, not least because consensus around the formation of a standard is typically beyond the reach of a single actor (Garud et al., 2002). This this limitation on the evolution of the infrastructure does not allow for directed control, but rather places indirect architectural limitations on its evolution, with the formation of a standard occurring in a distributed manner. Studies of the processes whereby this standardisation and convergence occur are also still in their infancy.

In general, the scale and complexity of digital infrastructures mean that distributed and indirect forms of control place few constraints on digital infrastructure evolution (Hanseth & Lyytinen, 2010; Star & Ruhleder, 1996).

However, these architecture-centric approached underestimate the significance of embeddedness for relational activities. A very large number of studies in the area of embeddedness have instead shown how social forces can shape economic activities reliant on artefacts—both enabling and constraining dynamic relationships. This is true of digital infrastructures, much as it was the case with inter-firm networks (Uzzi, 1997), path creation among high technology firms (Garud & Karnøe, 2003), and developments in large, established firms (Greenwood & Suddaby, 2006). To truly understand the consequences of economic activities' embeddedness requires an examination of "just how social structure constrains, supports or derails individual goal-seeking behaviour" (Portes & Sensenbrenner, 1993: 1321), in this case taking into account both the social and the digital structure in which those activities are embedded.

Infrastructural Embeddedness

Embeddedness as a concept has been adopted by researchers in a number of fields—from economic sociology (Uzzi, 1996), to organisation theory (Dacin et al., 1999), and network theory (Yan, Peng, & Tan, 2015). These perspectives all contextualise economic activity in patterns of social relations; Granovetter argued that "all market processes are amenable to sociological analysis and that such analysis reveals central, not peripheral, features of these processes" (1985: 505). Thus, embeddedness has come to be used as a counterpoint to studies that treated market transactions as rational, faceless and independent (Barber, 1995). Instead, market

activities are treated as contextualised and influenced by the contexts in which they are embedded.

Zukin and DiMaggio (1990), in discussing the embeddedness of economic action, identify four different kinds of embeddedness, namely structural, cognitive, cultural and political embeddedness. These perspectives are summarised in Table 10.

Table 10: Overview of past studies into embeddedness

Type of embeddedness	Definition of embeddedness	Theoretical foundation(s)	Example references
Structural embeddedness	Actions embedded in interactor networks where position, status and practices affect economic activities	Network theory, economic sociology	Gulati 1995; Uzzi 1996; Hargadon & Sutton 1997; Hite 2003
Cognitive embeddedness	Actions embedded in structured mental processes, including heuristics, norms around practices and biases	Cognitive psychology, economic sociology	Zukin & DiMaggio 1990; Garud & Karnøe 2003
Cultural embeddedness	Actions embedded in cultural models of authority and identity, where cultural forms may be either constitutive or regulative	Economic geography, economic sociology	Goodstein 1994; Hoffman & Ventresca 1999; Thorne & Saunders 2002
Political embeddedness	Actions limited (and enabled) by external rules and governance structures	Political economy	Nee & Ingram 1998; Greenwood & Suddaby 2006

A structural (or relational) embeddedness approach to understanding the activities of a firm zooms in on the networks of other actors within which a firm is embedded (Granovetter, 1985; Zukin & DiMaggio, 1990). This has come to be the dominant lens through which the embeddedness of economic activity is viewed (Dequech, 2003; Swedberg, 1997). These networks of actors not only comprise strategically important relationships (Dacin et al., 1999), they also offer strategically important resources in several ways. First, they connect the firm to other firms in closely connected within network with relevant resources (Gulati, Nohria, & Zaheer, 2000); second, they connect the firm to arm's length firms with resources, which complement those resources available in close networks (Langlois, 1992); and third, the position in the network may offer disproportionate benefits, for instance if the firm spans gaps in the network (Burt, 1993). Such access to resources includes not only access to assets like money, technology and skilled employees, but also access to flows of information (Uzzi & Lancaster, 2003), and social char-

acteristics like trust and legitimacy (Padgett & Ansell, 1993). Studies of structural embeddedness have shown how both competitive and cooperative relationships form in these networks (Gnyawali & Madhavan, 2001), that this embeddedness can affect managerial performance (Moran, 2005) and Open Source project success (Grewal, Lilien, & Mallapragada, 2006), and has led to new ways of understanding entrepreneurial behaviour (Simsek, Lubatkin, & Floyd, 2003).

Cognitive and cultural embeddedness are said to be closely linked to one another. While cognitive embeddedness refers to the "ways in which the structured regularities of mental processes limit the exercise of economic reasoning" (Zukin & DiMaggio, 1990: 15–16), cultural embeddedness refers to the "role of shared collective understandings in shaping economic strategies and goals" (Zukin & DiMaggio, 1990: 17) (p. 17). The two have been of particular interest for institutional theorists, who argue that culture forms a coercive force that, when one is embedded in it, regulates behaviours (Dequech, 2003). Culture similarly provides sets of values within which firms operate and which, through individual cognition, shape firm behaviours. Although culture has been pointed to as an important shaper of entrepreneurial behaviour (e.g. Shane, 2000), collective values can be hard to pin down precisely—and much of the research into culture and entrepreneurship has relied on Hofstedes's conceptions of national culture (1980, 2011). As a result, much of the research into the effects of cultural (and cognitive) embeddedness on entrepreneurship have relied on examining the institutions that comprise culture (Thornton, Ribeiro-Soriano, & Urbano, 2011). Studies have nevertheless found that culture shapes the perception of the value created by entrepreneurs (Korsgaard & Anderson, 2011), and that social capital—seen as vital for entrepreneurship—is culturally constrained (Audretsch, Aldridge, & Sanders, 2011).

Lastly, political embeddedness refers to the "manner in which economic institutions and decisions are shaped by a struggle for power that involves economic actors and nonmarket institutions, particularly the state and social classes" (Zukin & DiMaggio, 1990: 20)(p. 20). To my knowledge, political embeddedness has never been explored in entrepreneurial behaviour. However, business networks—particularly international ones (e.g. Halinen & Törnroos, 1998; Welch & Wilkinson, 2004)—get both their shape and their content from the political regimes in different countries.

Having discussed the different conceptions of embeddedness visible in extant research, I turn now to discussing how structural embeddedness and embeddedness in an infrastructure affect entrepreneurship.

Multi-Level and Nested Embeddedness

Economic activities have thus been observed to be influenced both by their broader environments and by more direct interactions (Osborn, Hagedoorn, Denekamp, Duysters, & Baughn, 1998). Indeed, this distinction is echoed both in classic sociological theory, which distinguished between dyadic (one-on-one) environments and larger group environments (Simmel 1950), as well as in network studies of embeddedness. Granovetter (1992), for instance, distinguishes between the effects of dyadic relationships and the effect of the overall network on actors' actions. He also points out that firms may belong to multiple networks with different and varying objectives; thus, are members of multiple, competing networks (Granovetter, 1992).

When it comes to the embeddedness of digital infrastructures, the vastness of the context in which entrepreneurial activity takes place means that they are embedded in three layers of context. The first of these is the dyadic relationships that they undertake with other entrepreneurs, including both those with which they compete, and those with which they cooperate (Uzzi, 1997). The second of these is inter-organisational embeddedness, which refers to the relationships that they form with other organisations reliant and active in that particular infrastructure, for instance regulators and funding providers (Avgerou & Li, 2013). Lastly, entrepreneurs are embedded in sociotechnical structures that include not just these social actors, but also the digital artefacts that comprise the infrastructure. These artefacts include other modules developed that rely on the infrastructure (as distinct from the entrepreneurs that developed them), inter-operable infrastructures and other elements of the infrastructure's digital architecture, including digital code (Leonardi, 2010).

The relational character of a digital infrastructure means that both modules and economic activities conducted reliant on it are, in turn, embedded in the larger relational structure. This means that entrepreneurs seeking to take advantages of the benefits of being part of an existing digital infrastructure embed themselves both in the infrastructure itself, and in its broader relational structure. Such a broader relational structure is known as "nested embeddedness" (Kenney & Goe, 2004). Consequently, not only are entrepreneurs embedded in multiple levels of embeddedness, but these levels may themselves embedded in one another.

Entrepreneurial Activity and Digital infrastructures

Field Embeddedness

A field in which an entrepreneur operates is defined as a dynamic area in which actors and artefacts subject to the same regulatory processes or shared meanings operate (Scott, 1995), with the boundaries loosely defined to include all of those "in the same boat" (Dacin et al., 2002: 51). Although studies of fields have typically looked at human actors in the field, the pluralistic nature of fields (Jarzabkowski & Paul Spee, 2009) and the focus on activities in fields (Bourdieu, 1988) leaves room for consideration of other artefacts as important elements of a field. It is with this in mind that the field around a particular digital infrastructure includes not just stakeholders such as competitors, suppliers, regulators, and consumers (Greenwood, Suddaby, & Hinings, 2002), but also elements of the infrastructure itself insofar as they influence processes, shared meanings and common activities.

Diffusion, Reproduction and Repurposing of Knowledge

Drawing on studies into cognitive embeddedness on the field-level, one of the main influencers of entrepreneurship using digital infrastructures is the diffusion of ideas and activities (Dobrev, 2001). Entrepreneurship reliant on a digital infrastructure is, for the most part, knowledge work aimed at delivering a product or service (Bechky, 2006). While knowledge in many contexts is often "sticky" or context-specific (Szulanski, 1996) and tricky to convert from tacit to explicit knowledge (Nonaka, 1994), this is less the case in this kind of knowledge work. Previous studies of knowledge transfer, which supports knowledge work, in information systems have distinguished between "knowledge as object", the kind of knowledge that is portable, "knowledge as cognition", the kind of knowledge that is needed to make sense of objects (for instance through procedures and optimisation), and "knowledge as capability", the skills and expertise to put objects and cognition into practice (Hsiao, Tsai, & Lee, 2006). Source code and expertise has a long history of being shared online, whether through open source repositories like Github (Shaikh & Cornford, 2003) or in peer-to-peer forums devoted to collectively supporting development (Fadel, Meservy, & Jensen, 2015).

Much of the knowledge involved in development of a module for an infrastructure is codified in the form of object code or source code (Alavi & Leidner, 2001), as modules built upon digital infrastructures take the form of digital code

(Yoo et al., 2010). Indeed, the existence of this codification and sharing culture mean that source code, seen as "knowledge as object" (Hsiao et al., 2006) is frequently transferred not just directly from one individual to another, but released for general use and appropriation. Indeed, such code often turns up in other software projects, whether legally or illegally (Haefliger et al., 2008). These low barriers to entry and the ease with which such code can be reproduced makes it incredibly likely that this code *will* be reproduced, in whole or in part, by entrepreneurs. This will both enable the production of more entrepreneurial ventures, but is likely to mean that they are less unique, thus suggesting a limitation on flexibility. One extreme case that has already been observed is cases of copycat versions of digital applications becoming available through infrastructures like Google Play (Goodin, 2013). Accordingly I propose that:

> Proposition One: **Reproduction** of knowledge-as-objects available online limits the flexibility of entrepreneurship based on digital infrastructures

In the same vein, the ability to interpret this codified knowledge requires not just access to the publicly available digital code, but also requires that individuals can make sense of the code that is available. This "knowledge as cognition" once required that and individual have a high level degree in computer science. Today, however, the availability of online resources, both in the forums already mentioned and through online courses means that the cognitive knowledge needed to repurpose pieces of pre-existing code is publicly available, usually for free or very little (Al-Atabi & DeBoer, 2014). However, online courses often teach only the most popular coding languages, and forums dedicated to common languages are the most extensive—and thus most useful. The availability of these online resources makes the repurposing of code for new and unique purposes more likely. However, the dominance of certain languages is likely to limit the scope of this flexibility. Accordingly, I propose that:

> Proposition Two: **Repurposing** of digital code, using knowledge as cognition, both enables and limits the flexibility of entrepreneurship based on digital infrastructures

Both reproduction and repurposing make use of a combination of knowledge available publicly within the field (McLure Wasko & Faraj, 2000). However, the production of the resources that make them possible rely on patterns of dyadic interactions. Accordingly, reproduction and repurposing are a product of dyadic embeddedness nested in field embeddedness.

While reproduction and repurposing do not require much in the way of creativity, taking existing code, understanding it, and applying it in a whole new realm

requires knowledge as capabilities (Avital & Te'Eni, 2009). This kind of knowledge is harder to obtain online, in part because it is hard to codify and in part because existing repositories of expertise cannot, by definition, cover unique and unexplored applications of existing code and existing understandings in the form of new entrepreneur-drive modules. However, this foundational knowledge can support the development of this creativity. Accordingly, I propose that:

> Proposition Three: Reproduction and repurposing allow for the **diffusion** of old ideas, encouraging flexibility in entrepreneurship based on digital infrastructures

These field- and nested effects are, however, not the only level in which entrepreneurs and the infrastructure are embedded. Instead, entrepreneurs are also involved in interactions, whether repeated or once-off, with a network of other organisations.

Inter-Organisational Embeddedness

Individual firms have a long history of cooperating with one another (Tjosvold, 1984). In general, cooperation is done because it is thought to be of mutual advantage, for instance through cutting costs by sharing assets (Johnson & Johnson, 1996), reducing transaction costs, improving internationalisation or otherwise providing a firm with competitive advantages (Johnson, Cullen, Sakano, & Takenouchi, 1996) or organisational knowledge (Inkpen, 2000). However, this kind of coordination has elements of power inherent in it, a dynamic typically examined in studies of political embeddedness (Dacin et al., 1999).

When it comes to entrepreneurship on digital infrastructures, multiple kinds of cooperation are necessary. The first of these is cooperation between the entrepreneur and the organisation that maintains the digital infrastructure, while the second is between individual actors, or dyadic relationships. In order to effectively cooperate, previous research has shown that firms need to have both common objectives and joint activities (Hagedoorn, 2006).

While there are instances of infrastructures that are disconnected from an organisation (See Andersen & Ingram, this thesis), most infrastructures are wholly or partly operated by an organisation, although they are typically influenced by other organisations and stakeholders. This influence is visible in the patterns of distributed maintenance and development of the infrastructure (Yoo et al., 2008). These stakeholders, in turn, set standards that entrepreneurs must adhere to if they want to make use of the underlying infrastructure. Here, I make a distinction between standards and categories.

Coordination through Standards and Categories

The standards I am referring to are largely artefact-based; for instance de jure standards that are necessary for module-infrastructure compatibility (e.g. Wu & Wang, 2005), such as segments of code or the use of specific object languages. Ethereum, a blockchain-based digital infrastructure, for instance, requires that modules developed for its DApp platform be developed using its own programming language, called Solidity, for which it provides extensive documentation.[9] *De facto* standards are also commonplace, for similar reasons. While in many cases the owner of a platform may require that a certain piece of code or language be used for compatibility reasons, in many cases it is just easier to operate within a certain digital infrastructure while making use of these artefacts—even if it is not impossible to do otherwise. Accordingly, I propose that:

> Proposition Four: **De jure and de facto standardisation** limit flexibility in entrepreneurship based on digital infrastructures

Categories, in contrast, are of more social nature. However, they are as commonplace as standards. By categories, here, I refer to the inclusion of certain kinds of modules and the exclusion of others (Jenkins, 2000). This kind of categorisation may take the form of de jure categorisation, as is the case when the Apple App Store or Google Play store include some applications and exclude others based on their age-appropriateness (Reisinger, 2015). It may also take the form of de facto categorisation, where some modules are treated as belonging to a certain category, making them more or less likely to be permitted on an infrastructure. Modules that mistakenly breach terms of service, or are mistakenly believed to be inappropriate for those below a certain age might be de facto excluded even though they are de jure permitted.

> Proposition Five: **De jure and de facto categorisation** limit flexibility in entrepreneurship based on digital infrastructures

Ultimately, standardisation and categorisation are necessary in order for firms to coordinate among themselves and for compatibility with the underlying infrastructure. Both the setting of standards and establishment of categories are therefore processes of negotiations, contestation and shared agreements between distributed actors (Hanseth & Lyytinen, 2010). Although entrepreneurial activity is embedded in the standards and categories that result, the formation of the standards and cate-

[9] Documentation for this language is available online at https://ethereum.gitbooks.io/frontier-guide/content/writing_contract.html

gories is a product of tussles between organisations embedded in the field, including infrastructure owners and would-be users. Indeed, this coordination may even entail cooperation across different infrastructures, for instance by using the login details from one infrastructure (e.g. Google) as authentication for another infrastructure (e.g. Evernote). The final organisation-level proposition is therefore one that is nested in field-level activities:

> Proposition Six: **Coordination** limits flexibility in entrepreneurship based on digital infrastructures

While multi-lateral coordination is central to development based on digital infrastructures, so too is one-on-one cooperation between individual entrepreneurs and individual stakeholders.

Trust and Dyadic Embeddedness

As described above, individual entrepreneurs' ability and inclination to engage with one another is nested in pre-existing norms around sharing of knowledge in the form of code and programming expertise (Wasko & Faraj, 2005). This structural embeddedness in networks of sharing gives entrepreneurs the tools with which to make use of the underlying infrastructural technology, if they do not already possess them, or troubleshoot during the process of module development.

However, how entrepreneurs ascertain which sources of code and expertise to rely on is not a nested function. Instead, it is a dyadic product of interactions between individuals and may rely both on cultural conceptions of embeddedness and structural embeddedness. In essence, it rests on the formation of relationships of trust between individual actors. There is no consensus regarding the exact definition of trust. However, within the context of online communities it has been defined as "a belief that is based on another's behavioural demonstration of benevolence, integrity, and judgment" (Porter & Donthu, 2008: 115), or the willingness of individuals, beyond profit motives, to use acceptable behaviours (Jarvenpaa, Knoll, & Leidner, 1998) to further the interests of both parties.

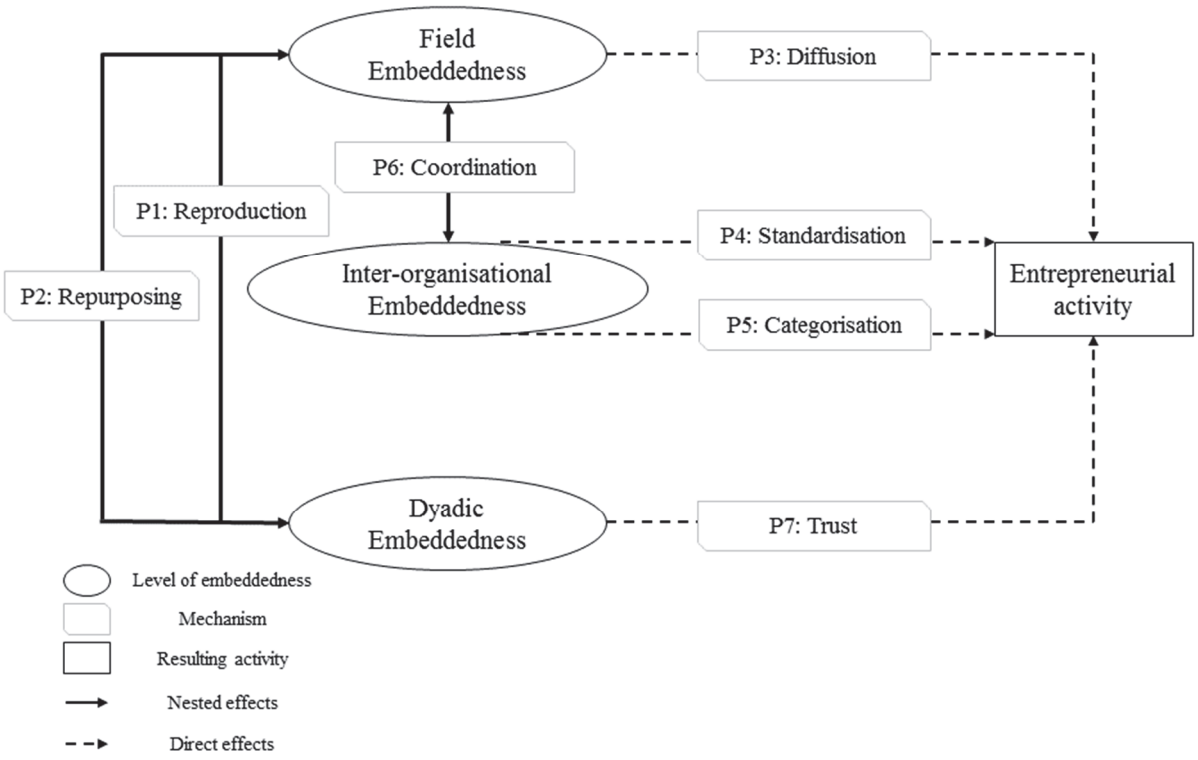
The formation of trust is a complex and multi-faceted process, and one that is beyond the scope of this paper to explore.[10] However, it relies, among other things, on individuals' willingness to share content with one another, without engaging in opportunistic behaviour (Gefen, Benbasat, & Pavlou, 2008), as well as help each other without expectation of reciprocity (Posey, Lowry, Roberts, & Ellis, 2010).

[10] However, see Porter & Donthu 2008; Gefen et al. 2008 for insightful discussions into the nature and antecedents of trust in online environments

What these point to is the difficulties that individuals both cooperating and competing have in forming trusting relationships with one another, a paradox that has been observed elsewhere (Uzzi, 1997). Where individual stakeholders manage to find common ground and trust each other, despite the fact that they are competitors, this is likely to facilitate module development and entrepreneurship. In contrast, failure to build trusting relationships is likely to limit what can be done using the digital infrastructure, notwithstanding the knowledge that already exists as a public good (Wasko, Teigland, & Faraj, 2009). Accordingly, I propose that:

> Proposition Seven: **Trust formation** both enables and limits flexibility in entrepreneurship based on digital infrastructures

Figure 5: Multi-level and nested embeddedness of entrepreneurial activity reliant on digital infrastructures

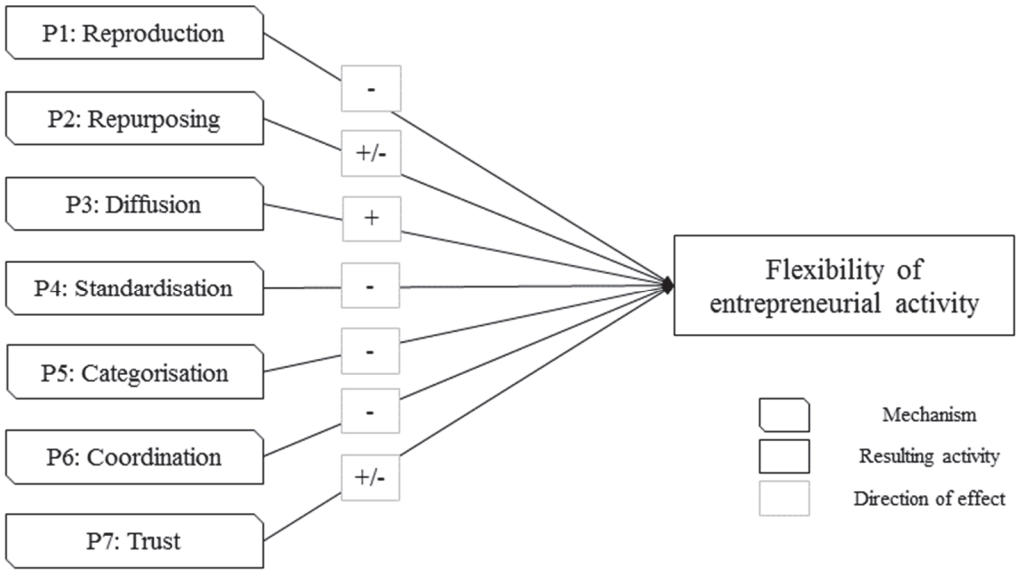


Embeddedness has elsewhere been observed to have dynamic effects, leading both to constraints on economic activity as well as new possibilities for economic activity (Dacin et al., 1999; Witt, 2004). This is as true of the flexibility of entrepreneurial activity reliant on digital infrastructures as it is of entrepreneurs operating in other fields. A summary of the dynamics of this multi-level and nested embeddedness is shown in Figure 5.

Discussion and implications

The aim of this paper was to expand on our understanding of digital infrastructures beyond their change, or evolution (Eaton et al., 2015; e.g. Henfridsson & Bygstad, 2013) and instead examine how infrastructural embeddedness impacts flexibility of entrepreneurial activity. As such, it draws on patterns of diffusion (e.g. Loh & Venkatraman, 1992; Lyytinen & Damsgaard, 2011), maintenance (Ghazawneh & Henfridsson, 2013; Leimeister et al., 2005; Moon & Sproull, 2008), reproduction (Baskerville & Myers, 2009; Swanson & Ramiller, 2004; Wang, 2010), and control (Eaton et al., 2015; Gosain, 2004) as they apply to entrepreneurship reliant on digital infrastructures. A summary of the direction of these effects when it comes to the flexibility of entrepreneurial activity reliant on digital infrastructures is shown in Figure 6.

Figure 6: The effects of embeddedness on the flexibility of entrepreneurial activity reliant on digital infrastructures



However, while this paper theorises around the mechanisms whereby embeddedness limits entrepreneurship among those reliant on digital infrastructures, and proffers propositions for further research, it does not examine what the direct consequences, whether intended or unintended, of this embeddedness might be. Some possible consequences might be specific kinds of entrepreneurial activity as a consequence of specific sets of certain artefacts, standards or categories, for instance. This conceptual paper therefore opens up avenues for further research into the

consequences of this embeddedness on entrepreneurs in this fast-growing area of entrepreneurship.

Theoretical Implications

In linking studies of embeddedness with studies of entrepreneurship and infrastructure, this paper opens up a wide number of areas for future research. These areas centre on the outcomes of this kind of embeddedness, but also frame possible areas for empirical research into embeddedness in this context.

The Role of Artefacts in Fields

The advent of the digital age has meant that formal and informal embeddedness is far vaster than perhaps Bourdieu (1988) or DiMaggio and Powell (1983) ever imagined. They include not only formal connections like suppliers and customers, but an enlarged community of informal connections, from online "followers" to the extended informal networks facilitated by social networks, to the knowledge-based forums where everyone from marketers to engineers shares ideas (Post, Preston, & Sachs, 2002). This has meant that the field around a digital infrastructure has grown incredibly large, with more and more organisations not only connected to each other, but connected to similar knowledge bases.

Moreover, these enlarged organisational fields have increasingly overlapped; leading not only to increased global competition (Cardona, Kretschmer, & Strobel, 2013), but also to increased cooperation as organisations are package their annual reports, public relations briefs and APIs in such a way that they comply with standards within the field. Lastly, this expansion of organisational fields has meant that the individuals within organisations have to collect, analyse and respond to more information than ever before. From social psychology research, we know that humans make poor decision-makers when faced with an abundance of choices (Gigerenzer & Gaissmaier, 2011), and that attention to detail may flounder in the face of such abundance (Posner & Petersen, 1989). It should come as no surprise, given the digital drivers of the expansion of the organisational field, that organisations increasingly rely on digital tools to structure, and even execute, much of their daily work. Some examples include the use of Enterprise Resource Planning (Soh & Sia, 2004), social media management tools (Kaplan & Haenlein, 2010), and even the use of robots (Beane & Orlikowski, 2015).

This expansion of the field draws us to engage with the question of what embeddedness actually means in the digital age. While this paper has pragmatically included artefacts as among the constellation of actors active in the field, the scope

for the role of these artefacts, especially given the abundance of information and communications that occur online, is ripe for further investigation.

Regulatory Outcomes

One of the most time-honoured traditions in embeddedness research is how power and rules form part of the context in which actors and organisations are embedded. This is as true for entrepreneurs that rely on digital infrastructures as it is for entrepreneurs and organisations in other contexts. Indeed, foundational work on embeddedness points to the importance of rules, whether *de facto* or *de jure*, and their importance in framing how economic activity proceeds (DiMaggio & Powell, 1983). Some possible avenues of inquiry might include the following: "How are rules are formed?", "When they vary, why do they vary?", and "Why do they take the forms that they do?

The construction of rules and hierarchies in other distributed contexts, for instance those in online communities, point to the flatness of hierarchies in digital, distributed contexts (Dahlander & O'Mahony, 2011). Social and cultural approaches to embeddedness are particularly interested in these processes of hierarchy, contest and struggle (e.g. Fligstein, 1991, 1996), and it is likely that these processes differ substantially when it comes to the distributed forces at work in the relational context of infrastructure formation and maintenance.

Governance Outcomes

Given the likelihood of new patterns of rules and hierarchies, what are the implications for governance when it comes to entrepreneurship using digital infrastructures? Uzzi (1999), for instance, finds that embeddedness reduces the need for formal governance models. He suggests that, rather than the costs of enforcement and monitoring, embeddedness allows actors to focus on the benefits of relationships—largely because embeddedness means that economic activity is largely self-governed.

This observation is particularly interesting given the amount of interest in governance mechanisms that digital infrastructures have already generated (Broadbent et al., 1999; DeNardis, 2012; Eaton et al., 2015). Digital infrastructures, and research into them, are largely at their infancy. It is therefore conceivable that digital infrastructures, embedded as they are, do not need clear governance mechanisms in the way that they are conceived of today. Instead, as in studies of structural and political embeddedness, is it conceivable that future digital infrastructures may be self-governing, with implications both for entrepreneurs and for other users.

Some avenues for further inquiry in this area therefore include the following: "Is there a need for formal governance mechanisms?", and "What are the difference between formal governance mechanisms and de facto constraints?"

One-On-One Outcomes

As this paper suggests, dyadic interactions between entrepreneurs reliant on digital infrastructures shapes much of the content of the ties in which the larger system is embedded. The dynamics underlying trust as a one-on-one outcome are of particular interest given the paradoxical relationship between competitors, in that they benefit from cooperating (Uzzi, 1997).

Previous research into these dyadic relationships has particularly highlighted the importance of reciprocity among actors (Gulati, 1995), as well as information asymmetries that allow for brokerage among certain actors embedded in multiple networks of dyadic interactions (Burt, 2009). The outcomes of these dyadic relationships are therefore likely to be affected by the distribution of actors and the centrality of the digital infrastructure as an artefact. Some possible research questions therefore include: "How does reciprocity affect trust in entrepreneurship reliant on digital infrastructures?", "How do repeated transactions shape the future of the underlying infrastructures", or "What is the role of social capital in encouraging entrepreneurial activity based on digital infrastructures?"

Temporal Outcomes

Lastly, given the long-term and temporal nature of digital infrastructures (Star & Ruhleder, 1996), as well as their penchant for distributed evolution (Henfridsson & Bygstad, 2013), it is possible that the embeddedness discussed above not only has implications for entrepreneurs that seek to make use of the infrastructure, but also for the infrastructure itself, beyond what has already been discussed in existing literature.

Some likely candidates for further study include the role of embeddedness in infrastructural evolution of activity over time (Dacin et al., 1999), including path dependence and path creation (Garud, Karnøe, & Kumaraswamy, 2010).

Implications for Practice

Choice of Infrastructure

Embeddedness studies have suggested that in many cases practitioners, including entrepreneurs, make choices based on existing mental processes (Zukin & DiMaggio, 1990) or cultural norms (Hoffman & Ventresca, 1999). When it comes to development using one or many infrastructures, the embeddedness of entrepreneurs, including nested embeddedness, may make certain choices easier or more obvious than others. For instance, a firm might choose an artefact or organisational structure that is less efficient than an alternative arrangement, in part because the decision makers did not recognise the additional transaction costs involved, as was the case in Jacobson et al.'s (1993) study of multi-national organisations.

The model introduced above highlights some of the areas of embeddedness that may affect entrepreneurial decision-making, whether for better or worse.

Focus on Oft-Ignored Infrastructure(s)

There is a rich stream of literature around the unintended consequences of technologies (e.g. Robey & Boudreau, 1999). In the case of technology as an infrastructure, as it becomes an integral part of an organisation and, as an infrastructure, blends into the background, the advantages that it presents may become unintentionally become overshadowed by the organisational imperatives that its maintenance and reproduction introduce. This points to a paradox: the more that as a technology becomes more infrastructural, it is more likely to be overlooked. Indeed, Star and Ruhleder observe that infrastructure is most visible when it fails (1996).

This paradox presents a puzzle for practitioners: while it is important to maintain the infrastructure, does focus on this introduce the risk of overlooking innovation and strategic advantage (Baptista, Newell, & Currie, 2010) in the name of coordination and control ?

Conclusion

Embeddedness, grounded in diverse areas of theory, is typically seen as a way of understanding the structure-agency dilemma, where human agents exercise bounded rationality within the structures in which they are embedded (Geels, 2004; Simon, 1982). This paper examined the different approaches to understanding embeddedness and, linking these with research into the emergent area of digital infra-

structure, proposed a model for how the embeddedness of an infrastructure, and thus of entrepreneurs who seek to make use of it, places limitations on its much-lauded flexibility.

However, while embeddedness is often regarded as a constraint (Liebeskind, Oliver, Zucker, & Brewer, 1996), if used strategically it can also create opportunities. This paper highlights how, for the most part, embeddedness acts as a constraint on entrepreneurial activity reliant on digital infrastructures. However, it also opens windows of opportunity for a select few; those able to master the creativity and trust-building possibilities that entrepreneurship in the age of digital infrastructures require. As such, this embeddedness erects barriers to entry and action for many, but not all, suggesting that infrastructures are neither as generative as previously suggested (Tilson et al., 2010), nor as democratic (O'Mahony & Ferraro, 2007).

Chapter 4

How Infrastructures Anchor Open Entrepreneurship: The Case of Bitcoin and Stigma[11]

[11] First author, co-authored with Marcel Morisse of the University of Hamburg. This paper is under fourth round revision at the *Information Systems Journal's* Special Issue on Digital Entrepreneurship.

Abstract

This paper delves into the question of how an entrepreneur commercialising an open source (OS) technology (an "open entrepreneur") responds when the underlying infrastructure becomes stigmatised, particularly when the source of the stigma is unclear.

Research into organisational stigma has found that the most effective and robust strategies for established, non-digital firms, when faced with stigma, is to try to distance themselves from it. In contrast, open entrepreneurs typically form part of a closely-knit OS community bound together by a shared ideology. This enables close collaboration within the community, and open entrepreneurs benefit from the resources that participation in the OS community provides. Given these competing imperatives and the importance of ideology, how—and why—do open entrepreneurs respond to stigma in the OS community?

This paper contributes to our understanding of open entrepreneurship by developing a model of ideologically-mediated responses to stigma through an inductive study based on interviews, archival and forum data. First, we discuss how the underlying infrastructure "anchors" divergent ideological groups, preventing them from distancing themselves from the OS community. Second, we show how free-riding on the OS community is not an option. Third, we develop a model of how sub-groups within the Bitcoin community make use of ideology in group membership *identification*, stigma *interpretation,* business model *enactment,* and response *salience.* Lastly, we show how ideological heterogeneity leads to business model heterogeneity among OS entrepreneurs, and discuss the practical implications of this research.

Key words: open entrepreneurship, stigma, ideology, open source communities, business models, Bitcoin

Introduction

Entrepreneurs working with Bitcoin, a digital currency that uses cryptography to execute and maintain records of transactions, are well-positioned to benefit from the currency's popularity (and the popularity of the underlying infrastructure)—assuming they survive the stigma of its early days. It has been hailed both as "the next internet" (Spence, 2015) and—in the same newspaper—the "most dangerous currency in the world" (Burn-Callander, Stone, & Laurence, 2014). The stigma entailed by the latter, in the early days of Bitcoin, was a stumbling block for would-be Bitcoin entrepreneurs all over the globe. As one entrepreneur said:

> When you're out to talk about [product], then someone says 'I though bitcoin went bankrupt'… (laughs) that's the signal that I really have to start from the beginning with this one. (Firm E)

Stigma is not uncommon among established firms in established industries: firms that make money from tobacco (Benson, 2008) and weapon sales (Vergne, 2012), for instance, not only survive, but thrive. However, these established firms often have deep pockets or influence from which to draw when responding to the stigma (Durand & Vergne, 2014), and the fact that their organisations and fields are established can work in their favour (Sine & David, 2003). In contrast, entrepreneurial firms have neither resources nor influence (Bullough & Renko, 2013; Sine, Mitsuhashi, & Kirsch, 2006), but may nevertheless survive to become the big firms of the future (Aldrich & Fiol, 1994).

A study of Bitcoin entrepreneurs is instructive when it comes to understanding stigma among new firms both because entrepreneurship online is on the rise and therefore topical (Mankevich & Holmström, 2016; Nambisan, 2016), and because these entrepreneurs make use of an innovative core Open Source (OS) technology. The community behind this technology may therefore support the nascent firm (Yetis-Larsson et al., 2015), and the underlying OS infrastructure may play a role in how—and why—these entrepreneurs respond as they do (Nambisan, 2016). While running a digital entrepreneurial firm requires more than just the underlying technology (Davidson & Vaast, 2010; Nambisan, 2016), the technological infrastructure remains a vital part of the entrepreneurial undertaking and recent research has

called for it to be explicitly considered in digital entrepreneurship processes (Nambisan, 2016).

Research into stigma among established organisations has found that creating distance—for instance by divesting of assets or through narrative—from the source of the stigma is a robust strategy when it comes to dealing with its consequences (Devers et al., 2009; Durand & Vergne, 2014; Lamin & Zaheer, 2012). However, the centrality of the shared infrastructure in the case of Bitcoin means that creating distance from the technology, on the face of it, would be harmful if it even were possible. Moreover, as the infrastructure is maintained by an OS community; creating distance from this community may limit entrepreneurs' ability to affect the development of the infrastructure (O'Mahony & Ferraro, 2007b). Instead, staying close to the OS community may provide the resources necessary to overcome the stigma (Siobhan O'Mahony, 2003; Yetis-Larsson et al., 2015).

Extant literature therefore outlines a tension that open entrepreneurs face when considering how to respond to stigma at the level of infrastructure. While stigma has never before been examined among open entrepreneurs specifically, the OS literature points to the benefits of community engagement, including how community members support one another. In contrast, organisational research into stigma points to the dominance of distance as an important stigma response. Thus:

> How do open entrepreneurs in the Bitcoin community form stigma responses?

We answer this empirically-driven research question through a qualitative study of the Bitcoin community and of European Bitcoin entrepreneurs during a stigma-enhancing event, namely the very public collapse of the Mt.Gox Bitcoin exchange in early 2014. Thought of as the "entry point for newbies" and whose exchange rate was cited by, among others, the *New York Times*, Mt.Gox declared bankruptcy amid a cloud of speculation. The publicity surrounding this event drew newspaper headlines across the globe (e.g. Abrams, Goldstein, & Tabuchi, 2014; Dougherty & Huang, 2014) and the lack of a clear explanation for it meant that the already-stigmatised infrastructure itself became viewed with increased suspicion ("The Troubling Holes in MtGox's Account of How It Lost $ 600 Million in Bitcoins," 2014). In interviews, open entrepreneurs described how this meant that they faced additional suspicion from regulators, banks and potential customers, over and above what they had already faced. The event necessitated a response, entrepreneurs said.

We start by presenting existing understandings of open entrepreneurs and digital infrastructures, before examining extant literature on stigma responses, ideological ties and the importance of like-minded groups. We then present our research

setting and design, our findings, and discuss the implications of this research for open entrepreneurship and stigma research.

Open entrepreneurs working together

Open Entrepreneurship and Infrastructures

Entrepreneurship in general is thought to create jobs and drive innovation (Van Praag & Versloot, 2007). While entrepreneurship is often defined as the creation of a new enterprise (Davidsson, Low, & Wright, 2001), it could more broadly be defined as the examination of opportunity discovery, the evaluation and exploitation of that discovery, as well as the analysis of whom, how, and the effects of these processes (Sarasvathy & Venkataraman, 2011; Venkataraman, 1997). Given the innovativeness of OS technologies, and their importance online, it is no surprise that entrepreneurial firms increasingly rely on OS technologies and communities, in what has come to be called "open entrepreneurship" (Yetis-Larsson et al., 2015). These open entrepreneurs face the same opportunities and constraints as entrepreneurs, however the fact that they also rely on shared digital code and typically have ties to an underlying OS community may affect how they run their firm. However, despite entrepreneurship in the digital realm being squarely a focus of government and academic interest (Davidson & Vaast, 2010; Mankevich & Holmström, 2016; Nambisan, 2016; Zhao, Barratt-Pugh, Standen, Suseno, & Redmond, 2017), the role of the digital artefacts themselves are largely undefined and poorly understood (Nambisan, 2016).

Firms that primarily operate in the digital realm are incredibly heterogeneous (Davidsson, 2007) owing—at least in part—to their use of multiple, flexible tools (Gans & Stern, 2003; Kallinikos, Aaltonen, & Marton, 2013). The use of these digital artefacts, platforms and infrastructures has resulted in a wide variety of business models (Björkdahl, 2009; Keen & Williams, 2013), fast internationalisation (Greenstein et al., 2013; Reuber & Fischer, 2011), and low barriers to entry and exit (Davidson & Vaast, 2010; MacInnes et al., 2002). They also mean that entrepreneurs can (relatively) easily tailor their services for specific markets and sets of stakeholders (Nambisan, 2016; Yoo et al., 2010). This flexibility has seen theorists suggest that digital entrepreneurship has "increasingly porous and fluid boundaries" (Nambisan, 2016: 2), and has led to a call for research that explicitly examines the role of digital artefacts, platforms and infrastructures in digital entrepreneurship, rather than just as tools or contexts in which entrepreneurship occur (*ibid.*)

A digital infrastructures, in the form of code, forms a base upon which entrepreneurs build businesses, for instance through Apps in an online App Store (Eaton et al., 2015), or by creating cloud-based services upon which other services can be built (Keller, Szefer, Rexford, & Lee, 2010). Infrastructures are defined as including not only a core underlying technology upon which platforms and modules can be built (Yoo et al., 2010), they also have relational properties that stem from the organising practices of human actors (Star & Ruhleder, 1996). This means that for a technology to be considered infrastructural depends both on an objective assessment of how it is used, and a subjective assessment of how it is seen. For instance, entrepreneurship through modules built upon a platform, in the case of the Apple App Store, has previously been seen as rendering that platform infrastructural (Eaton et al., 2015).

The relational properties of an infrastructure are affected when an infrastructure becomes stigmatised by one or many groups. While the stigmatisation of a digital infrastructure has never before been examined, attributing relational characteristics to digital technologies is not unheard of (See Benbasat & Wang, 2005 for further discussion).

Stigma and Subjectivity

Stigma can shake an entrepreneurial venture to its core. This is because stigma adversely affects how firm members see themselves (Tracey & Phillips, 2015), or how the firm is seen by outsiders (Lamin & Zaheer, 2012). Stigma is said to be "a collective stakeholder group-specific perception that an organization possesses a fundamental, deep-seated flaw that deindividuates and discredits the organization" (Devers et al., 2009). In essence, it is a subjective perception. How the stigma is perceived and interpreted by those whom it affects is therefore also likely to rely on subjective assessment.

Stigma can occur for one of three reasons: first, as a consequence of an event or practice (Tracey & Phillips 2015), for instance when a firm goes into bankruptcy (Sutton & Callahan, 1987) or makes use of sweatshop labour (Lamin & Zaheer, 2012); second, for being part of a category of firms which have become stigmatised, for instance those seen to be adversely affecting the environment, such as by commercialising nuclear power (Eyles & Fried, 2012) or supporting violence and war, such as in the arms industry (Durand & Vergne, 2014); and third, by association, for instance by associating with a stigmatised organisation such as a firm catering to a stigmatised group like unwelcome immigrants (Tracey & Phillips, 2015) or gay men (Hudson & Okhuysen, 2009).

The stigmatisation of an infrastructure may affect different firms in different ways, depending on their use and perception of it, as strategies that work in some contexts do not work in others (Lamin & Zaheer, 2012). Indeed, previous research has shown that the meaning ascribed to technological artefacts is shaped by the complex networks of individuals and organisations that use them (Knorr-Cetina, 1999; Orlikowski, 2007). In previous studies of firms tainted by association, continuing "business-as-usual" in the face of stigma meant ascertaining what kind of environment the firm found itself in, and drawing the appropriate boundaries, for instance by divesting of tainted assets (Durand & Vergne, 2014) or through reasserting legitimacy through denial, defiance and decoupling from the source of the stigma (Lamin & Zaheer, 2012). In other contexts, organisational ideology has meant that valorisation of the stigmatised group may be an effective strategy (Tracey & Phillips, 2015). When a core infrastructure becomes stigmatised, much depends on subjective assessments of how the technology is seen, and what its role is in the entrepreneurs' nascent firms.

The values ascribed to the infrastructure and the manner(s) in which it is used, including when used by heterogeneous groups for different purposes, are therefore relevant considerations when examining how infrastructure affects stigma responses among open entrepreneurs. Indeed, it has been hypothesised that "Exogenous shocks to an industry [like stigma] will increase the likelihood that strong identities will develop and be maintained in that industry" (Peteraf & Shanley, 1997, p. 178, brackets ours).

Identity and Ideologies

Entrepreneurial firms, like other organisations, are known to classify themselves into groups defined according to their social identities (Powell et al., 2014; Sonenshein, Nault, & Obodaru, 2017; Tajfel & Turner, 1979) Such identification refers to "cognitive, moral, or emotional attachment to a group based on similar attributes" (Webb, Tihanyi, Ireland, & Sirmon, 2009: 497). What is considered central to a particular group is context-specific, and grows out of the group's experiences. It is also fluid and malleable (Kreiner, Hollensbe, & Sheep, 2006). Some central traits are observable (e.g. firm size, service or product offering), while other traits (e.g. institutional histories or social networks) are implicit or unobservable (Peteraf & Shanley, 1997). While the boundaries between these groups are blurry (Reger and Huff, 1993), they are distinctive enough that differences are discernible even to outsiders (Peteraf & Shanley, 1997). Important identities cause individuals and groups to "seek opportunities to enact the identity, to define a situation as

identity-relevant, and to retain and recall identity-related information (especially identity-consistent information)" (Ashforth & Johnson, 2001: 32).

Among OS communities, ideology is seen as the glue which holds the community together (Choi, Chengalur-Smith, & Nevo, 2015). Ideology, or "shared, relatively coherently interrelated sets of emotionally charged beliefs, values, and norms… bind[s] some people together and help them make sense of their worlds" (Trice & Beyer, 1993). It has also been shown to motivate members of shared communities to work together (Nov, 2007), and is often the reason why members give away ideas and source code (Bergquist & Ljungberg, 2001). Over and above the ideological ties to a community, participating through sharing knowledge, contributing code or otherwise supporting the community can signal an individual's skills, increase their reputation, and ultimately lead to private rewards (Lerner & Tirole, 2005) including leadership in that community (O'Mahony & Ferraro, 2007b). However, multiple ideologies are not uncommon, or even necessarily a problem (Stewart & Gosain, 2006).

The initial developers of the Bitcoin infrastructure are known to have had Libertarian tendencies (Dallyn, 2017). However, as the infrastructure has begun to be used by more diverse groups and individuals, more ideologies have been introduced into the mix. Recent research into the dynamics of the Bitcoin community have pointed to the frictions between those with different ideologies (Dallyn, 2017), including among entrepreneurs (Ingram & Morisse, 2016).

Given the importance of ideology, it should come as no surprise it is possible that an ideology could form the core of a group identity (Glynn, 2000), or a mutual understanding of the "central, enduring, and distinctive characteristics of the group" (Peteraf & Shanley, 1997), as distinct from other groups.[12] An entrepreneurial firm may therefore define group identity along ideological lines.

Identities and Entrepreneurs' actions

Entrepreneurial firms, like other organisations, make decisions in line with their identities (Pratt & Foreman, 2000). Identities are thought to be particularly important among nascent firms (Lee, Hiatt, & Lounsbury, 2017) and in identifying competitors and collaborators (Sonenshein et al., 2017; Wu & Olk, 2014).

Firms, including entrepreneurs, have been seen to use identity management strategies (Powell et al., 2014; Pratt & Foreman, 2000) and, in so doing, attempt to strike a balance between stakeholders that can help the firm today, and those who

[12] Although firm identity theories have been criticised for attributing micro-level characteristics to macro-level collectives (Pratt & Foreman, 2000), in this case the entrepreneurial firms were typically run by one dominant individual. We therefore saw no problem in attributing that individuals' ideology to their firm.

can help the firm in the long-term (Mitchell, Agle, & Wood, 1997; Mitchell & Cohen, 2006). Indeed, identity can be particularly important for entrepreneurs as they try to achieve business objectives (Bucar & Hisrich, 2001) or respond to adversity (Powell et al., 2014) in that they help a firm identify organisations and individuals who share their interests (Mitchell et al., 1997; Pratt & Foreman, 2000). Such interests are crucial when choosing a business model—defined as "the content, structure, and governance of transactions designed so as to create value through the exploitation of opportunities" (Amit & Zott, 2001) and stakeholders—defined as "any group or individual who can affect or is affected by the achievement of the firm's objectives" (Freeman 1984, p. 25), including customers, suppliers, regulators, and a constellation of other individuals and organisations (Harrison & Freeman, 1999). Among open entrepreneurs, both the OS community and members of the offline world, whether customers or otherwise, are important stakeholders (Miles, Miles, & Snow, 2006; Zhao et al., 2008).

Multiple identities are commonplace in OS communities: while all are members of the larger community (Ljungberg, 2000), and typically identify as such[13], the loyalties of some may lie more with their own subgroup or project[14] than with the community at large (Stewart & Gosain, 2006). That said, multiple identities, and membership of multiple groups[15], need not result in competition or conflict (Sonenshein et al., 2017). The ability to appeal to multiple groups may give a firm flexibility in the long-term (Ashforth & Mael, 1989; Pratt & Foreman, 2000), and membership of multiple groups may lead to synergy and disproportionate gains (Pratt & Foreman, 2000).

Where firms are members of more than one social groups, their allegiances may be different at different times, depending on situational cues (Rousseau 1998). In contrast, "deep structure identification" involves a "fundamental connection between individual and collective" (Ashforth, Harrison, & Corley, 2008) that is less variable. Indeed, social psychology suggests that as people inhabit multiple roles and are members of many social groups, identities only affect behaviour when they become salient (Powell et al., 2014). Consequently, where an organisation is a member of multiple groups, identities might variously be compartmentalised, aggregated, deleted or integrated, in response to environmental stimuli (Pratt & Foreman, 2000). Allegiances and actions based on salience, or the fit between a potential behaviour and the constraints of a group identity (Oakes, Turner, & Haslam, 1991), may be implemented through physical, spatial, or symbolic strategies.

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[13] Or higher order identity

[14] Or lower level identity

[15] In discussing group identities, we draw on social identity theory from social psychology (Tajfel & Turner, 1979)

Having discussed how the use and stigmatisation of a technology is subjective and therefore is likely affected by ideology, as well as how ideology affects open entrepreneurs' choice of business models and group membership, we turn now to discussing our research setting and methods, before turning to our findings around open entrepreneurs' responses to stigma.

Research Setting

Faced with the theoretical puzzle outlined above, we were intrigued by how Bitcoin entrepreneurs attempt to both run and grow a Bitcoin business in the face of stigma, while also remaining part of the larger—stigmatised—OS community dedicated maintaining and developing the Bitcoin infrastructure. The collapse of Mt.Gox provided an "extreme case" that heightened this tension (Yin, 2009), and thus the opportunity for us to understand how these tensions played out. On the face of it, entrepreneurs experienced stigma through their association with the OS community.

Bitcoin's story begins in 2008 with an anonymous person or group, known as Satoshi Nakamoto, releasing a white paper describing "an electronic cash system" named Bitcoin (Nakamoto, 2008b). Nakamoto disappeared in 2009. Before his disappearance, Bitcoin developed into an open source movement and at the time of writing was being maintained and developed by an active community of supporters and users (Yelowitz & Wilson, 2015). The protocol uses established cryptographic methods to form a decentralised peer-to-peer network, in which pseudonymous users can send and receive payments (Brito & Castillo, 2013).

The initial Bitcoin community was said to be heavily influenced by Libertarian ideologies, and many argued that cryptocurrencies were a desirable alternative to the conventional financial system (Maurer, Nelms, & Swartz, 2013). Members of the underlying community were also linked to illicit goods and services through its use in Silk Road, an online marketplace (Christin, 2013), as well as to money laundering and fraud (Stokes, 2012). Both illicit dealings and Libertarianism tend to be stigmatised in mainstream communities.

A number of entrepreneurs had built businesses that relied on the Bitcoin infrastructure. Mt.Gox, one of the earliest and most prominent of these, was founded in 2010 and by 2013 was handling 70% of all Bitcoin trades (Vigna, 2014). Problems with withdrawals and exchanges on its service began in 2013, however, and the firm eventually declared bankruptcy in February 2014. This came as a shock; as one interviewee put it:

> The official website for Bitcoin [Bitcoin.com] recommended them as one of the top exchanges and then when that happened then all the news outlets also recommended them and every time, [as the] media loved to do, they would cite the Mt.Gox price. They were a big name and were a powerful brand that beginners would go to (Firm D).

The bankruptcy of this high profile firm exacerbated entrepreneurs' existing sense of being stigmatised, and they faced renewed criticism, notably in coverage of the bankruptcy by mainstream media like *The New York Times* (Popper & Abrams, 2014) and the *BBC* (2014).

We now turn to the data and methods and data we used to analyse this stigma, before linking them back to ideologies, stakeholder alignment, business models and open entrepreneurs' responses to stigma.

Research Design, Data Collection and Analysis

Given our interest in the dynamics between ideology, open entrepreneurship, and stigma, our data collection and analysis overlapped considerably, and was iterative in nature (Eisenhardt, 1989). We relied on interviews from a unique sample of Bitcoin entrepreneurs, Reddit (forum) data and archival data.

We pursued an inductive case study approach (Eisenhardt, 1989; Yin, 2009) in order to understand how the entrepreneurs dealt with the stigma they faced. In so doing, we relied on 1) Forum data, which we analysed using computational and manual coding; and 2) Interview and archival data, which we analysed using open coding and triangulated against other sources. Our methods and data are summarised in Table 11 and discussed further below.

Table 11: A summary of the data collected and methods of finding and analysis

Description	Collected data	Findings and Analysis
Interviews		
Interviews with Bitcoin entrepreneurs in Denmark, Germany, Finland, Poland and Sweden	10 formal, semi-structured interviews recorded and fully transcribed. Participants selected to represent multiple countries and overlapping business areas Conducted in English and, in one instance, German. The interviews lasted 40-75 minutes and were transcribed fully.	Data coded by two authors Extensive written notes on coding and findings Articulation of findings using analytical memos (Miles & Huberman, 1994) Fortnightly meetings to discuss findings

Description	Collected data	Findings and Analysis
Documentation		
Archives and documentation on Bitcoin, Bitcoin commercialisation and the Blockchain	121 Press articles 78 Posts on key topics from other sites (e.g. Bitcoinfoundation.org, Coindesk.com, Techcrunch.com)	Broadened scope of findings Compared interview findings with broader discussion Comparison on key issues
Community data		
Forum posts and comments, divided into 6 periods	1058500 forum posts scraped from reddit.com/r/Bitcoin, covering a period of one year We divided the data into 6 periods, defined as before and after the five events described in Appendix One	Analysed using Latent Dirichlet Allocation (LDA, Blei et al. 2003).) and manual open coding to tease out representative ideologies in the data

Computational Analysis of Forum Data

The Bitcoin community is known to discuss Bitcoin in online forums and on social media platforms. We therefore made us of Reddit forum data to understand themes and conversations in the Bitcoin open source community as they relate both to ideology and interpretation of stigma.

To analyse the community data we applied the computational topic modelling technique Latent Dirichlet Allocation (LDA) (Blei et al., 2003). LDA exposes latent themes within a set of documents by sampling a topic for each word at every iteration of the algorithm and ranking words based on their 'relevance' to each topic (Chuang et al., 2012; Griffiths & Steyvers, 2004), which therefore has a unique distribution over words that can be compared using similarity measures. This technique allowed us to identify relevant themes and common conversations in the Bitcoin community to understand ideology and stigma in Bitcoin.

We gathered 1 058 500 Reddit posts over a period of one year, which we divided into 6 periods for longitudinal analysis. These periods are not intended to be theoretically significant, but rather allow us to conduct a longitudinal analysis without drowning out less common, but still important, themes. Our analysis generated six interactive graphs, with 30 topics per period, each containing the 30 most common words used per topic. The topics were presented according to their semantic proximity to one another. We treated these 5 400 initial words and their relationships to other words and topics as something akin to first order codes. We then coded them further to generate axial and selective codes, where the selective codes correspond to the ideologies described in our findings section.

In order to engage with the entrepreneurs in the community, as well as examine the reasons behind why these entrepreneurs responded to stigma in the way they did, we also collected interview and archival data. This was done because one of the limitations of computational analysis of the form described above is that it

shows correlation rather than causation, and we wished to examine the "why" of these entrepreneurs' behaviours.

Interviews and Archival Data

We identified Bitcoin entrepreneurs in multiple European countries, and across multiple areas of operations. We ultimately interviewed 10 entrepreneurs operating in Denmark, Germany, Finland, Poland and Sweden. The intention was to choose a sample of entrepreneurs that was diverse and therefore theoretically insightful. However, despite compiling a list of a number of firms using and commercialising the cryptocurrency, we were unable to identify who was running the firms, and from where in the world. This meant that our sample, though small, constituted the entire identifiable population of firms active in the Bitcoin space in these five countries at the time our interviews were conducted (July to November 2014). This unwillingness to be publicly identified makes sense given the stigma we observed (and which entrepreneurs confirmed). They are nevertheless a diverse group and offer a theoretically insightful population.

Interviews were supported by an interview guide which focused on: 1) the entrepreneurs' use and commercialisation of Bitcoin, 2) their relationship to the larger Bitcoin community, 3) their relationship to external stakeholders, including authorities, banks and other actors; 4) how the entrepreneurs perceived the stigmatisation of Bitcoin, and 5) what, if anything, they did to mitigate the effects of stigma.

The two authors independently conducted open, inductive and iterative coding using qualitative data analysis software. The codes were summarised into axial and selective codes, and linked to each other with analytical memos (Miles & Huberman, 1994). We discussed differing interpretations to ensure rigorous results (Gibbert et al., 2008). Consistent with previous research into ideology in Information Systems (Stewart & Gosain, 2006), we treated ideologies as something that could be "uncovered" by close reading, as they were communicated through language and communication (Van Dijk, 1995).

We triangulated our analysis with news articles from traditional media outlets (e.g. *Wall Street Journal* or *Bloomberg*), platforms that specialised in Bitcoin news (e.g. Bitcoin.org or Coindesk.com), and our knowledge of the Bitcoin ecosystem from our own involvement in it.

When it came to the entrepreneurs' ideologies and interpretations of stigma, we cross-referenced our findings against ideologies held by members of the Bitcoin community through the analysis of the Bitcoin sub-Reddit described above (Reddit, 2016).

We now turn to presenting our findings.

Findings

Identity and the Infrastructure

The centrality of the Bitcoin infrastructure was a recurring theme in both the forums and in our interview data. Although the technical nature of the infrastructure was the same for all those who used it, they opted to build different modules that relied upon it, and related to it in different ways.

By clustering the language used in the forum data, and then coding the clusters to create higher level codes, we examined the different perceptions of the infrastructure. We reasoned that teasing out how the infrastructure was perceived on both a social and a technical level would guide us in understanding differences in responses to stigmatisation. Using iterative coding, we built up nuanced understandings of the key social groups in the community. While there were areas in which these groups overlapped, they were distinct enough to be identifiable.

The top-level codes that we settled upon related to the ideological persuasion of community members. The ideological lens through which they saw the infrastructure, and thus its commercial future, is visible in how the infrastructure is described, and the beliefs, values and norms attributed to the infrastructure. These understandings of the infrastructure, the ideologies, and example quotes are contained in Table 12. Consistent with earlier research (Glynn, 2000; Hensmans, 2003; Stewart & Gosain, 2006), we observed ideology to form the core of the identities of these groups.

Table 12: Ideologies and interpretation of stigma in the broader Bitcoin community

Ideology	Description of Infrastructure	Interpretation of Stigma	Beliefs, Values, and Norms	Illustrative Quotation
Decentralist	Open source, distributed, security, control, free,	Stigmatised due to centralization of power, which led to exploitation by powerful actors	Beliefs: Democratic Values: Bitcoin Foundation [as neutral, community representative actor] Norms: Decentralisation	If bitcoin can't handle large institutions than it can never reach the soaring heights that its speculators are hoping for. That, right there, is what's wrong in the argument. P2P is no less capable even though it is fundamentally different. Your premise is still using centralised logic, but there is no reason why soaring heights can't be achieved through P2P. The thing is that we still haven't figured out how exactly, but it'll get there, step by step (2013-03-20 08:31:45).
Libertarian	Trust, libertarian, Austrian (economics), control, power, anonymous,	Stigmatised due to presenting a libertarian alternative to established financial systems	Beliefs: Anonymity, individual responsibility Values: Outside existing system, Entrepreneurship, Taxes Norms: Libertarian, anti-authority, limitation of power	I'm a diehard ancap, libertarian, and voluntarist. Really, really. […] Bitcoin by design appeals to free marketeers and voluntarists the world over, and this is a good thing - the free market continues to be the most empowering and equalizing force humanity has ever seen. […] The growth and acceptance of Bitcoin necessitates and simultaneously facilitates the further ushering of a world where sovereign individuals are free to act and serve each other as they please. […] (2013-03-15 10:50:29)
Mainstream	Conversion, USD, fiat currencies, exchange rates, banks, capital gains, regulations,	Stigmatised due to lack of authorities' oversight, leading to stigma-inducing behaviour by individuals	Beliefs: Taxes (negative), Legal status, Mt.Gox legal status, Need for regulations Values: Exchanges, Transactions, Link to existing system, Growth Norms: Interoperability	If you do not have large institutions, long-term, than bitcoin will not appreciate, because not having large institutions limits the total volume of wealth stored in the bitcoin economy. If bitcoin will not appreciate, long-term, they're not analogous to precious metals (2013-03-20 04:04:25)

Ideology	Description of Infrastructure	Interpretation of Stigma	Beliefs, Values, and Norms	Illustrative Quotation
Pragmatist	Cooperation, regulations, customer, support, exchanges, transaction (volume), alternatives	Stigmatised due to behaviours of a smaller but unavoidable number of individuals with sinister motives	Beliefs: Payments, Outside recognition Values: Customer service, Exchanges Norms: Link to existing system, Interoperability, Transfers	Speculators can also be users. In fact, as their hoard grows the urge to spend some must also grow (2013-03-20 12:43:34).
Skeptic	Laundering, bad, illegal, Silk Road, Ponzi	Stigmatised as the libertarian nature of the systems fails to reign in illicit behaviour by individuals	Beliefs: Illicit use, Fraud, Mt.Gox theft, Mt.Gox unprofessional, Mt.Gox trust, Criminal uses Values: Security, Need for regulations (MtGox) Norms: Legality, Trust	When the top is reached and the buyers are exhausted, the speculators (of which are most people who own BTC) will head for the exits and try to cash out, making the value plummet. It's the same story as with every other speculative bubble in the history of mankind. But I get it, people become blind with greed, they'll soon deny the reality in front of them, and then finally be filled with regret that they didn't cash out when they had it good (2013-03-20 23:57:34)
Speculator	Investment, buy, risk, value, bubble, taxes, capital gain, volatile	Stigmatised due to cutting edges in the system exploitable by individuals	Beliefs: Speculation, Bubble Values: Investment, Transactions, Exchanges, Trading Norms: Valuation, Prices	What aspect of speculation is actually bad? In order to actually make money speculating, they must buy when there is surplus supply in a market and sell when there is a shortage, with enough of them competing in a free market should cause stability. The people who are bad, are typically analyst, as they are trying to herd investors (2013-08-06 13:26:44)
Systemist	Cooperation, exchange, stability, inflation, economy, banks, crash,	Stigmatised because of rogue agents—system itself will survive stigma in the long-term	Beliefs: Bitcoin value, Bitcoin's meaning, News, Understanding, Trolling, Bitcoin passion Values: Interoperability, Global adoption, Outside existing system (tech), Risks Norms: Inflation, Economic of Bitcoin, Volume, Cash	What makes you in favor of Bitcoin? I'd like to see a cashless society. When you start using bitcoin and see where/how it could be used, it starts to feel a bit silly carrying lumps of metal and paper money about. Bitcoin has all the properties of cash and more. It also holds its value better than GBP (2013-06-20 20:21:44)

Ideology	Description of Infrastructure	Interpretation of Stigma	Beliefs, Values, and Norms	Illustrative Quotation
Technologist	Intrinsic value, security, mining, tokens, 51% attack, fees, bots, volume	The technology, if used correctly, eliminates weak nodes, and thus rogue behaviours	Beliefs: MtGox ddos, Mt.Gox technical problem, MtGox theft, Threats Values: Mining, Trading, Entrepreneurship, Technical, Software, HowTo, Hardware Norms: Security, Transaction, Open Source, Technology	Has memory technology been developing at a fast enough rate to keep up? Maybe in three years terabytes will be what gigabytes cost now. Maybe the blockchain technology will accelerate memory technology (2014-02-10 02:45:06).
User	Exchange, learn, blockchain, Paypal, fees, tax,	Uncertain/indifferent as to source of stigma	Beliefs: Bubble, Understanding, Exchange, Hopes Values: Transaction, Wallet safety, Wallet security Norms: Costs, Customer service	And as a non-industry user of bitcoin who wants bitcoin to be accessible to the masses, I am cheering for the big dogs in bitcoin who are trying to make it easier for everyone to break into the bitcoin economy. (2013-08-07 00:48:13)

For instance, among some groups (Decentralists and Systemists), the decentralisation of the infrastructure was seen as democratising the infrastructure—and thus removing it from central control (and, by implication, meddling). In contrast, others (Mainstream and Technologists) saw this decentralisation as important because it provided additional transaction processing capacity, making the infrastructure more effective. These ideologically-framed understandings of the underlying infrastructure highlight ideological divides, and the importance of these ideologies for the users of the Bitcoin infrastructure.

These ideological understandings of the social and technical elements of the Bitcoin infrastructure extended to the different groups' understandings of the stigma around the infrastructure.

Libertarians, for instance, identified both money laundering and governments' dominance as a source of stigma:

> True story: I have a friend who thinks bitcoin is technologically very cool, but he doesn't support it on "philosophical grounds". Why? Other than the laundering stigma, he believes in our government's economic policy and would rather sacrifice his own wealth to inflation than allow that policy to fail. (2014-01-30 15:33:52).

Meanwhile, pragmatists suggested that proximity to illegal activities had lead to the stigma and argued that public opinion would change, and thus laws would change too:

> …There is a stigma attached to Mary Jane and it is in the best interest of the bitcoin community to distance itself from anything related to illegal drugs. Moral and philosophical viewpoints on the matter are irrelevant. Bitcoin is not in the position to supersede the law. In the finance/trade community the law comes first. Crypto currency has the potential to undermine "the man". Bitcoin can be occupy wall street in a suit and tie with purpose. But note that popular opinion will make the call and as passionate as you may be about love, peace and trees. Bongo drums and bongs will not further the cause. Save it for the afterparty. (2014-01-17 06:28:08)

Mainstream members of the community called for businesses and individuals to cooperate with established actors, and authorities in particular:

> If you really want change, take baby steps. Do not antagonize society and their governments before they have "seen the light" (2013-05-30 21:15:37)

However, one of the weaknesses of clustering as a method of data analysis is that it only shows correlations between certain words and other words. Without the context surrounding these discussions, it is hard to understand the dynamics that gave rise to these understandings, as well as their implications—both when it comes to

inter-group relationships and when responding to stigma. We therefore undertook interviews in order to understand how these ideological differences affected entrepreneurs' responses to stigma.

Stigma as Identity-Relevant

The Bitcoin entrepreneurs interviewed in this study identified, first and foremost, as members of the Bitcoin community; that is, as members of larger community within which there were multiple groups. However, these different ideological camps—and associated identities—became apparent as a result of the renewed need to respond to the stigma associated with Bitcoin. Without a clear reason for who—or what—was to blame for the stigmatisation of the Bitcoin infrastructure, and what the effects of the most recent stigma-enhancing event might be, entrepreneurs were forced to interpret what they saw around them. Entrepreneurs in the Bitcoin community were thus quick to interpret the stigmatisation of the infrastructure as something that was identity-relevant.

Four social groups with distinct identities, characterised by ideological beliefs, values, and norms, were identified during interviews through qualitative data analysis (summarised in Appendix Two)[16].

Identities on the poles of the ideological spectrum were inconsistent with one another, consistent with their opposing views of authority and individual responsibility, but overlapped with those in the middle. The two ends of the spectrum were so divided that they claimed that their opponents' behaviour was the source of the stigma, which in turn had rubbed off on those using the cryptocurrency:

> You have a lot of libertarianism in this market, and of course [firm] is openly fighting the banks and every authority, damaging the work we're trying to do, that is: establishing working relationships with the banks. And that's been very consistently. (Firm I)

> They [banks and regulators] don't like us, [they say that] it's all money laundry and stuff, but that's not the problem, the problem is that they are afraid of us because we're going into their turf and trying to take their customers. (Firm E)

This polarisation was further reflected in how the entrepreneurs interpreted the source and consequences of the Mt.Gox event, and thus the renewed stigma. These views were interpreted in line with ideologies in multiple different ways.

[16] Although more ideologies, and thus identities were visible in the larger Bitcoin community, it should come as no surprise that only a sub-set of these are visible in the entrepreneur community: the larger community contains more than just entrepreneurs, and therefore represents a wider variety of identities.

Mainstream entrepreneurs zoomed in on the importance of Mainstream legitimacy, which included subscribing to norms of professionalism:

> We actually expected it to happen much sooner. We saw it coming and we thought it would happen probably even a year ago, but it was good it didn't. Everything was kind of running unprofessionally… (Firm H)

In contrast, Technologists and Libertarians blamed individual users for consistently choosing a single exchange, contributing to too much centralisation:

> We cannot have centralised institutions [referring to Mt.Gox's market dominance] holding people's money without any transparency and with incompetent software (Firm D).

However, while Libertarian entrepreneurs insisted that centralisation was something inherently bad (because it centralised power, inviting corruption), Technologists argued from the position of the technology; they pointed out that centralisation created vulnerabilities in the technology, which unscrupulous people could then exploit.

Pragmatists believed that a certain amount of unprofessionalism on the part of Mt.Gox was to blame for the enhanced stigmatisation that followed, but were hesitant to draw any larger patterns. They thought that the source of the stigma in the community was due to actions by a few rogue individuals, and that as new users and enthusiasts were introduced, their more ethical behaviour would outweigh earlier unethical associations.

Responding to the renewed stigma caused by the collapse of Mt.Gox meant that entrepreneurs turned to their understandings of the events, and to their stakeholders, before making any decision. However, both the understandings of the events, and the entrepreneurs' choice of business model and stakeholders were the product of identity.

Business Models, Groups and the Infrastructure

Not only was stigma explained with reference to the entrepreneurs' identities, but the extent to which the entrepreneurs relied on the underlying infrastructure (as part of their business models) was limited by their group membership (summarised in Table 3). Please note that when we refer to business models, this also refers to important stakeholders, as they are also part of a business model.

Libertarian entrepreneurs, for instance, provided core services that were automated or operated as two-sided marketplaces, in which they did not plan to intervene. This emphasis on self-reliance meant that these entrepreneurs saw little

reason to interact with banks or regulators and did not wish to exert control over their platforms—in the name of not placing limits on individual autonomy. However, because they believed in enabling individual autonomy, they were heavily involved in the OS community. Their group identity, as Libertarians, therefore drew them close to customers who were self-sufficient and members of the OS community, while distancing them from banks and authorities in the offline world.

Mainstream entrepreneurs found themselves anchored to the OS community through the underlying technology, but they did not require the social or technical support of the community beyond what was publicly available. Their chosen group included not only banks and authorities, but also customers interested in using Bitcoin within the existing financial system. This was because these entrepreneurs provided core services that typically associated with the existing financial system, such as through wallets (instead of bank accounts) or retail sales of Bitcoin (like a central bank), or provided a point of connection with the traditional financial services sector. These direct-to-customer services were thought to entail obligations when it came to customers, even if these limited individual autonomy:

> Our role is it to make it as simple easy and user friendly as possible… Next year we need to have an insurance for Bitcoin reserves. People need the feeling that their funds are safe with our company. (Firm I)

Entrepreneurs identified as Technologists had the strongest underlying ties to the technology itself, and saw the technology itself as key to their firm's success. They therefore worked very closely with the OS community, owing to their need to influence the technical development of the infrastructure. These entrepreneurs, while providing core services similar to those provided by entrepreneurs with other ideologies, notably Libertarians, were distinctive insofar as they were completely indifferent to any actors outside of their group membership, which included onlt their customers and members of the OS community. They typically emphasised the technology's role in their business model:

> I think there is a high probability that cryptocurrencies will be a primary option, not only for payment, but also for voting and trading. Our [platform] is forwarding this development, and our range of view is about four years, from the initiation in last July. From that time, we hope to have established a foothold, foremost in [country], but also to have helped the adoption of cryptocurrencies worldwide. (Firm F)

Pragmatists, while also anchored to the technology itself, were not committed to any particular view of customers; they sought to maximise their revenues at any cost. Their core services therefore varied widely, and they exhibited a mercenary willingness to co-operate with all actors, whether those in the OS community or

banks and regulators offline. These entrepreneurs built their business using the technology and believed in its promise, but did not see the OS community—or cooperating with it—as important beyond its maintenance of the infrastructure. As such, they made use of both the OS community, and banks and regulators, when and if they were useful—for instance by relying on partners to do work that they did not wish to do themselves.

Thus, underlying ideologies affected not only how entrepreneurs interpreted the source of the stigma that affected them, but also the business models that they pursued and the stakeholders they saw as important in pursuing them. The combination of these two elements ultimately affected what the entrepreneurs saw as appropriate and effective ways to respond to the stigma that they faced. Having discussed the interplay between identity, stigma interpretation and business model, we turn now to discussing the effects of these ideologically-driven mechanisms on stigma mitigation responses.

Table 13: Ideologies, services, stakeholders, and unique and universal responses

Ideology	**Firm**	**Business Model**		**Other group members (also includes customers)**		**Source of stigma (as interpreted)**	**Responses to stigma**	
		Service Type	Attitude to customers	Community Involvement	Bank/regulator involvement		Unique	Universal
Mainstream	C	Peer-to-peer exchange platform, wallet service	Customers treated as needing support, in need of link(s) to banks	Reliant but avoids endorsing community	Active cooperation, oversight provides certainty	Unprofessional actors and lack of oversight	Operational controls, Collaborate with banks/authorities Emphasise own status offline	Emphasise own status within Bitcoin Community Draw Boundaries from contaminated firms
	I	Direct-to-customer exchange platform						
Pragmatist	G	Hardware retailer and cloud service provider	Needs of customers are market-driven	Indifferent to community	Indifferent	Actions by fringe actors and lack of understanding from outsiders	Collaboration with any actor that could give short-term benefits, Technical controls	
	H	Retail exchange platform		Reliant but avoids endorsing community	Selective cooperation			
Technologist	A	Peer-to-peer lending platform	Customers treated as potentially self-reliant, given right technical support	Reliant but limited involvement	"Wait and see" approach	Misunderstanding of the social and technical benefits of the underlying infrastructure	Double down on OS community involvement, Public education, Technical controls	
	B	Consulting services and hardware reseller		Actively involved	"Wait and see" approach			
	D	Startup incubator and consulting services		Reliant but limited involvement	"Wait and see" approach			
	F	Technical consulting service		Reliant but limited involvement	Avoided interaction			

Ideology	**Firm**	**Business Model**		**Other group members (also includes customers)**		**Source of stigma (as interpreted)**	**Responses to stigma**	
		Service Type	Attitude to customers	Community Involvement	Bank/regulator involvement		Unique	Universal
Libertarian	E	Direct-to-customer exchange platform	Customers treated as self-reliant	Actively involved	Avoided interaction	Government(s) and incumbent actors threatened by infrastructure independence	Double down on OS community involvement, Public education	
	J	Peer-to-peer exchange platform						

Responding to Stigma

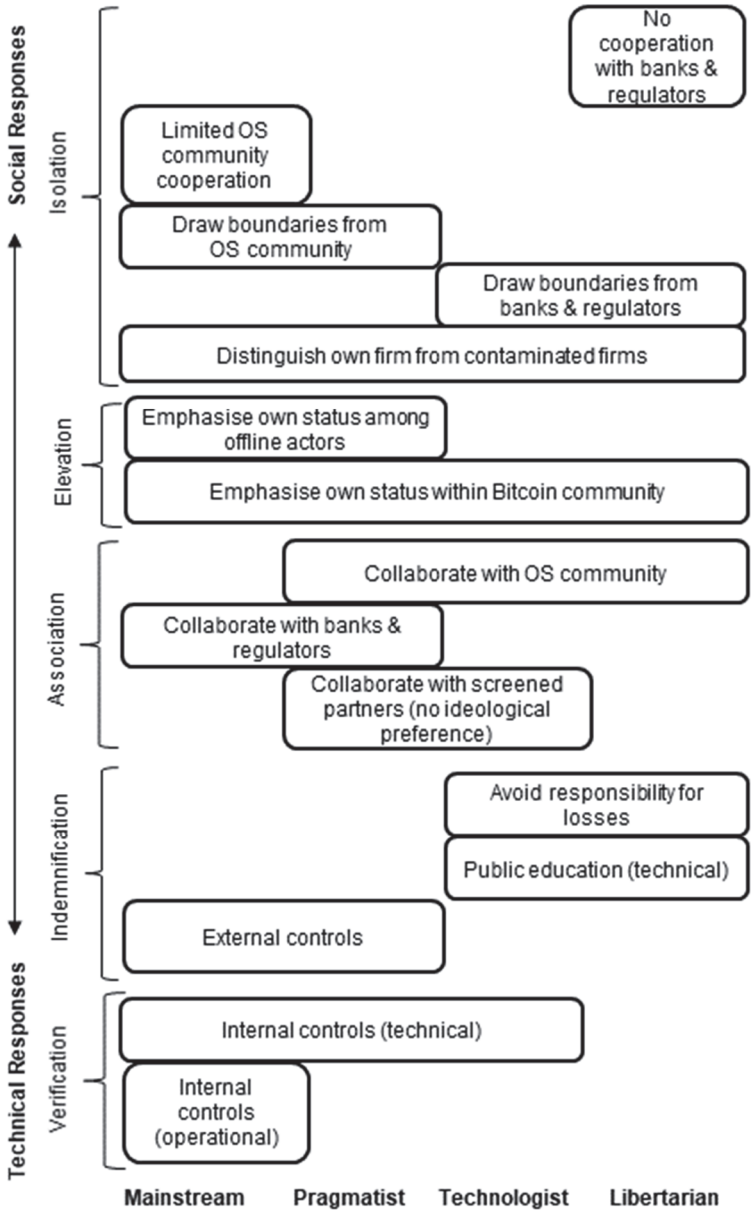
Although the entrepreneurs identified as being members of both the larger community and smaller, ideologically-defined groups, the smaller groups were the most relevant when it came to responding to stigma. This was largely because the entrepreneurs' group membership and interpretation of the stigma were influenced by their ideological views. Membership of the four groups, business model and interpretation of stigma, gave rise to common responses to the stigma, as well as responses that were unique to each ideological group. These characteristics and responses are summarised in Table 13. In order to make sense of these responses, we clustered them into five different archetypes. These types were directed at different groups of actors and different technical characteristics of the infrastructure. The archetypes are summarised in Figure 7 and discussed below. The coding process whereby we identified these responses is contained in Appendix Four.

Isolation

Entrepreneurs on the extremes of the ideology spectrum went to significant lengths to avoid working with groups with ideologies on the opposite end of the spectrum, but did not go as far as publicly vilifying them. Responses ranged from an unwillingness to engage with authorities or banks (Libertarians, believing them a threat to individual liberty), to an unwillingness to actively engage with the OS community (Mainstreamers, owing to the OS community's perceived unwillingness to consider any kind of oversight). One Libertarian entrepreneur, for instance, appealed to local courts to avoid disclosing customer information to a tax authority, while another withdrew platform operations in a third country as a knee-jerk response to government inquiries.

Those entrepreneurs that had limited reliance on either the OS community (e.g. for referrals and testing) or external stakeholders (e.g. as a way to make services more user friendly) opted not to isolate themselves from other groups, but nevertheless sought to point out differences between themselves and those holding extreme ideologies on both ends of the spectrum. Firms across the board distanced themselves from Mt.Gox and other firms that they perceived to be behind the most recent uptick in stigma.

Figure 7: Entrepreneurs' responses to stigma



Overall, Isolation strategies included only social responses: entrepreneurs did not supplement their business models or service offerings in any way. This divide reinforced the belief by Mainstream and Libertarians that opposing forces were to blame for the stigma that Bitcoin faced, as described above.

Elevation

A near-universal response to the stigma was to emphasise how the firm was "exceptional" relative to other firms—as defined by the ideology to which the firm's founders subscribed—and an exemplar of how other firms within the Bitcoin

space *should* operate. This elevation was less about appealing to group members, but rather about appealing to other Bitcoin entrepreneurs (and users) to subscribe to their ideology—and help them in projecting the community as something consistent with their view of what it should be.

Thus, Elevation, while largely a social response, had little effect on how entrepreneurs plied their trade. However, it did occasionally affect the narrative they used when describing their service(s), as they showed the salience of their responses to the stigma:

> We needed a link between the new financial system and the existing financial system. And that's how I see the exchanges. […] And that's how things were running … so we essentially are tied in as an integral part of the existing financial services in the society and by that better be able to do the migration from the existing services to something that might come in the future, based on digital currencies. (Firm H)

Mainstream firms emphasised how, even among their Mainstream counterparts, they were pioneers when it came to cooperating with authorities, sometimes going even so far as to assist authorities in drafting legislation. Pragmatists emphasised the lengths that they had gone to link up the Bitcoin network with the existing financial system, for instance through cooperating with banks or pre-empting likely regulatory shifts. This strategy exposed how, despite polarisation, heterogeneous members of the community nevertheless thought of their ideology—and their vision for Bitcoin's future—as being the best thing for both the community and the technology. This strategy also exposed how both the entrepreneurs' group membership and the narrative surrounding the underlying technology were shaped by their ideologies.

Association

When it came to responding to the stigma, including scrutiny from regulators and criticism from the media, ideology determined upon whom entrepreneurs chose to focus their attentions. Pragmatists, Technologists and Libertarians collaborated with members of the OS community, for instance by checking for flaws in the underlying technology. Interestingly, close involvement with the OS community was so anathema to Mainstream entrepreneurs that, despite their reliance on the underlying technology, they opted not to participate in community collaborations, for instance in testing for bugs. They did, however, keep track of the publicly released findings of others' collaboration and follow (and contribute to) community-level discussions.

Association was visible in a combination of social responses and technical responses. Mainstream actors, for instance, implemented onerous "Know Your Customer" (KYC) and anti-money laundering (AML) requirements, as banks are required to do:

> Luckily now, we have built for more than a year a relationship with one of the top banks, by just sticking to being very transparent to them. (Firm I).

This was despite the fact that the implementation of these requirements was not legally required of them, and adversely affected their customers' experiences on the short term.

Pragmatists believed that Bitcoin's role in the future was certain; they therefore sought to build a bridge between the existing financial system and the Bitcoin community. Building this bridge meant cooperating with both banks and regulators, and community stakeholders but only pursuant to furthering their business model needs. Therefore, while both Mainstream and Libertarian entrepreneurs opted only to work with ideologically like-minded firms (in turn reinforcing their business models), Pragmatists and, to a lesser extent, Technologists sought out partnerships that furthered their businesses interests, irrespective of their partners' ideologies. One Pragmatic exchange, for instance, bought large numbers of Bitcoins from a patently Libertarian supplier in order to increase their supply of the currency.

Indemnification

Verification and Indemnification refer to entrepreneurs' attempts to draw boundaries between themselves and the *technical consequences* of the stigma. Responding with Indemnification entailed entrepreneurs not just verifying technical service systems, but bringing in external parties to indemnify them against customer and stakeholder accusations. There was a stark divide here between the externally-minded Mainstream and Pragmatic entrepreneurs, and the Technologists and the Libertarians. The former brought in experts to conduct cryptographic audits of their accounts (and the Blockchain at large); something that was seen as particularly important given their belief that the stigma stemmed from unprofessional behaviour or technical incompetence. These audits were intended to signal that customers' money was secure, given their belief that customers needed their support.

Technologists and Libertarians, in contrast, argued that it was the responsibility of individuals to take care of their money—something that they considered to be both liberating and a responsibility, as described earlier. They therefore did not offer to hold customers money, nor refund them if something went wrong. Howev-

er, they sought to educate new and potential Bitcoin users about the risks involved in Bitcoin, how the technology worked and, in particular, the risks involved in the centralisation of too much money at any single exchange or firm.

Verification

In order to verify—both for themselves and for their customers—whether they had been affected by the Mt.Gox events, entrepreneurs engaged in Verification exercises. These took the form of controls on their technical systems of two types: operational and technical. All of the entrepreneurs, bar the Libertarians, sought to ensure that their own modules reliant on underlying infrastructure was secure. This included examining their software for evidence of bugs and tampering. The Libertarians instead argued that as all software code and transactions were publicly available, users and customers would (or should) verify technical systems themselves.

Mainstream entrepreneurs, who interpreted the stigma as resulting from unprofessionalism and saw their customers as reliant on them, implemented operational controls such as checking work processes, hiring additional employees, and pro-actively seeking out customers to explain what had happened to avoid further stigmatisation:

> We are doing everything that we can do, what is recommended to us and what will be maybe required to do. (Firm C)

There is therefore an ideological flavour to these otherwise technical responses, and they relate to the entrepreneurs' interpretation of the Mt.Gox events for their customers and other relevant actors, as well as the fear of loss and other service weaknesses, viewed through the lens of their ideologies.

The responses ranged mainstream on the left, to libertarian on the right (x-axis). Consistent with their polarised ideologies, Mainstream and Libertarian entrepreneurs typically used strategies with the most extreme orientation, while Pragmatists and Technologists made use of more mixed strategies. The entrepreneurs' responses to stigma also ranged from Social to Technical (y-axis). While Social responses were largely driven by group membership, service responses were driven by business models.

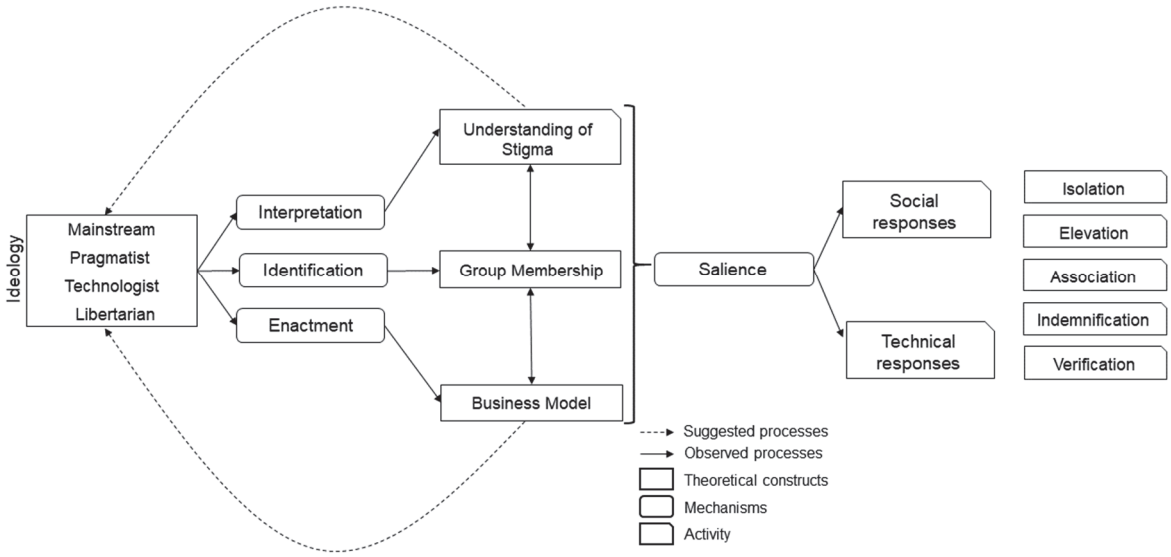
Overall, all four groups considered their interpretation of the Mt.Gox events, their group membership and the services they offered when ascertaining how (if at all) to respond to the renewed stigma. This assessment involved examining the salience of possible responses, before choosing those consistent with these constructs. The resulting responses ranged from being social to technical in nature.

Having shown how ideological alignment creates identity "groups" which, together with a firm's business model, explain how an entrepreneurial firm responds to stigma, we turn now to developing a model based on these findings.

A Model of Ideology-Influenced Responses to Stigma

Although the entrepreneurs saw the stigma through the lens of their identities, and in particular interpreted the source of the stigma in line with their identities, they were limited in how they could respond. While they could differentiate themselves and their firms from actors outside of the Bitcoin community, they could not do the same with organisations and individuals within the Bitcoin community. Using language drawn from studies of group identity (Ashforth & Johnson, 2001; Pratt & Foreman, 2000), we develop a model of stigma response strategies by Bitcoin entrepreneurs. This model is shown in Figure 8, and we discuss it further in the discussion section that follows.

Figure 8: Processes leading to ideologically-influenced stigma responses by open entrepreneurs



Ideology formed the core of the groups in which entrepreneurs saw themselves, how they understood the stigma that the community was facing, and the services which they offered.

In particular, ideologies formed the core of entrepreneurs' identity, and thus their group membership. Examining their core ideologies, entrepreneurs used the process of identification to identify more with some groups—groups which included OS community actors, banks and regulators, or both. These other group members included both likeminded entrepreneurs and likeminded other stakeholders, for instance banks (Mainstream) or miners (Technologists).

These ideologies also informed how the entrepreneurs chose, marketed and defined their service offerings. In developing their service offering they therefore enacted their ideologies. Those who saw the future of Bitcoin as being "cash on the internet" with few connections to the existing infrastructure (Libertarians and Technologists), for instance, built up service offerings that did not rely on non-Bitcoin (mostly offline) actors or infrastructures.

Lastly, ideology formed the lens through which the entrepreneurs interpreted the stigma that they faced. This interpretation of events as being identity-relevant is shown in the different causes that the entrepreneurs saw as underlying the stigma, as well as how they saw they stigma affecting both their own group members and their service offerings. Entrepreneurs with the belief that customers were, and wanted to be, responsible for their own money, for instance, operated minimum-intervention marketplaces, or peer-to-peer platforms, while those that preferred the simplicity of being able to interface with the existing financial system instead provided core services with more oversight. These two service offerings cater to different customer bases. Changes in business model also seemed to affect the entrepreneurs' ideologies, but this relationship is also deserving of further examination.

Group membership, stigma understanding and business model are not only all informed by the entrepreneurs' underlying ideology, they affect one another: as entrepreneurs cooperate with like-minded group members, and interpret the stigma, they think about how it affects their service. This highlights the fact that stigma is not just informed by multiple, often fragmented audiences (Hudson & Okhuysen, 2009) but, in the case of multiple firms affected by the same stigma, by heterogeneous ideologies which affect how stigma was treated and responded to.

These three initial constructs not only influence one another, they form the base for an assessment of the salience of the stigma for a single entrepreneur, and thus the formation of an appropriate response. This assessment of salience formed the basis for the entrepreneurs' decisions about how to respond to the stigma, both in social and in technical terms. The former tended to be heavily influenced by the entrepreneurs' ideology and stakeholder alignment, while the latter responded explicitly to perceived service-level threats, although this perception was, itself, affected by ideology.

In summary, the stigma mitigation strategies we have identified are treated as processes that multiple firms using a core technology may use to survive in the face of stigma. Having shown the dynamics around ideology, stigma interpretation, group membership, service offering and ultimate stigma response, we turn now to discussing the theoretical and practical implications of this paper.

Discussion: The Infrastructure Unites

While OS communities are often made up of many sub-groups with heterogeneous ideologies (Stewart & Gosain, 2006), they remain part of an overarching group linked both by shared ideologies and their reliance on the underlying infrastructure (Ljungberg, 2000). Open entrepreneurs are a particular kind of OS community. Thus, while literature looking at OS communities is enlightening, it makes sense to temper it with literature that explicitly considers organisations with economic and profit-driven motives (Durand & Vergne, 2014; Sonenshein et al., 2017).

In this section, we show the theoretical implications of our study of stigma, ideology and group membership in the Bitcoin community. In particular, we discuss: 1) The importance of infrastructure as a social "anchor" among open entrepreneurs; 2) Our model of ideology, group membership and stigma responses, and what it tells us about open entrepreneurs; 3) How the OS community and the infrastructure are nearly interchangeable; 4) How ideology contributes to entrepreneurial heterogeneity; and 5) The implications of this research for practitioners.

Anchors and Multiple Identities

In discussing online-offline personas, researchers have pointed to how one identity (offline) can limit the expression of another identity (online), or "anchor" it (Zhao et al., 2008). In this case, the digital infrastructure of the Blockchain serves as an "anchor" which links this diverse group of entrepreneurs, limiting their options when it comes to, among other things, stigma response.

When it comes to group identities, we find that this anchoring effect means that groups become so closely tied to one another that despite considerable differences they must respond and interact with one another. Thus, the shared infrastructure means that the Bitcoin entrepreneurs exhibit "deep structure identification" (Ashforth et al., 2008, p.339) with other members of the Bitcoin community—despite their ideological differences—by virtue of their shared use of the OS infrastructure.

The fact that individual firms identify with the larger community even though sub-groups have formed is consistent with earlier research. This broader group

ideology breeds trust, and facilitates team effectiveness (Ljungberg, 2000; Stewart & Gosain, 2006) pursuant to maintaining the shared infrastructure. Ideological differences have also been shown to motivate members of shared communities to work together, to the exclusion of outsiders (Nov, 2007).

An example of this anchoring lies in how Mainstream actors, despite limiting their cooperation with the OS community (seen as the bastion of Libertarian support), nevertheless elevate themselves within the larger Bitcoin community—which includes the OS community.

However, while the larger group identity "anchors" how much the sub-groups may distance themselves from the larger community, it does not prevent these sub-groups from cooperating with outside actors, nor from demonising individual firms within the larger group.

Free-riding Not an Option

While it should be theoretically possible for Bitcoin entrepreneurs to sever their ties to the OS community, even the most Mainstream-minded entrepreneurs declined to do so. While they did not publicly defend the OS community, even the Mainstream entrepreneurs nevertheless engaged with them. This is counter-intuitive as knowledge shared online is known to become a public good (Siobhan O'Mahony, 2003). That is, people cannot be excluded from using it and use by one person does not prevent it being used by others (Baldwin & Clark, 2006). Thus, the Mainstream actors could make passive use of this knowledge.

Given this non-excludability, one would expect entrepreneurs who find the OS community anathema to merely free ride on the publicly available knowledge. However, this was not the case: even the most extreme actors acknowledged the necessity of the underlying community and the work that it did (for instance code development and testing for code bugs, as was the case with transaction malleability), and engaged in discussions with the OS community, even if they sought to publicly distance themselves from other behaviours by the OS community.

There are a number of possibilities for why this was so. First, as an entrepreneur in a fast-paced environment like this one, something more than just public information may be necessary. This is consistent with previous findings around knowledge, which suggest that in-depth knowledge is a source of competitive advantage (Gupta & Govindarajan, 2000). Moreover, social capital in the community, which requires close community involvement (Yetis-Larsson et al., 2015), explains some of this non-severability. Another explanation involves the technology itself: as the Bitcoin is developed and governed in a decentralised manner, there is a likely incentive for the Bitcoin entrepreneurs to get involved in the maintenance and

governance of both, in the interests of making sure that its developments 1) do not undermine their own ideologies, and 2) do not threaten their current or future business models.

Indeed, although all of the entrepreneurs saw stigma in the community as being a consequence of association with "bad" behaviour by other members of the community, it ultimately became attached not to a single group or person, but rather to the underlying technology. Thus, although the entrepreneurs interviewed labelled this kind of stigma as "stigma by association", it more closely resembles that of core stigmatisation, where to avoid the stigma would mean abandoning an entire business model (Hudson & Okhuysen, 2009).

A Model of Ideology, Group Membership and Stigma Response

Stigma has elsewhere been acknowledged to be subjective (Tracey & Phillips, 2015). That is, while one set of attributions may entail stigma for some communities, the same set of attributions may not entail stigma for others. This helps to explain why, for instance, male bathhouses are stigmatised by non-users, while users merely try to avoid being stigmatised by outsiders (Hudson & Okhuysen, 2009). However, what we see here is more complex: where the source of the stigma is uncertain, both the causes and consequences of the stigma are subject to interpretation. Ideology, therefore, becomes a key element of making sense of the stigma—and responding to it.

First, drawing on group identity theory, we develop a model of how ideology provides an OS entrepreneur with the information needed to decide whether the effects of stigma are salient—and how—for his or her firm. The four processes involved, namely group membership *identification*, stigma *interpretation,* business model *enactment,* and response *salience* are processes derived from group identification and are supported by extant literature (Ashforth et al., 2008; Ashforth & Mael, 1989; Pratt & Foreman, 2000).

Second, we show the importance of group membership in the direction of these strategies. Entrepreneurs' ideologies meant that they were members of one group to the exclusion of the others, and that other groups could be the object of stigma mitigation responses. Thus, Bitcoin entrepreneurs used substantially similar strategies but directed them towards different stakeholders, depending on their ideologies.

Third, the responses ranged from being social in nature, for instance in the use of Isolation or Elevation strategies, to technical in nature, for instance through Verification and Indemnification. The full range of these strategies reflects the ef-

fects of the entrepreneurs' ideologies, with stakeholder alignment important in the formation of stakeholder strategies, business models (which are themselves ideologically influenced), and service-level responses.

Thus, we have teased out the indirect and direct effects of ideology on how, and why, entrepreneurs respond to stigma in the manner in which they do. In so doing, we have teased out not only the patterns of events that led to stigma mitigation responses, but also how and why these patterns occurred (Pentland 1999). Ideology operates directly by affecting which groups the entrepreneurs align themselves with (and which they seek to avoid), and by framing their interpretation of how the stigma would affect them. Ideology also operates indirectly by projecting onto the entrepreneurs' choice of, and narrative around their, business model.

These strategies bear resemblance to those observed in previous studies, most notably when it comes to the drawing of insider/outsider boundaries (Hudson & Okhuysen, 2009; Tracey & Phillips, 2015) and attempts by firms to divest themselves of as much of the link to the stigma as possible (Durand & Vergne, 2014). However, by teasing out the underlying processes whereby these strategies are formed, we also provide empirical guidance for future open entrepreneurs as they respond to stigma.

However, while previous studies have been undertaken in established industries with a non-digital character (Devers et al., 2009; Durand & Vergne, 2014; Hudson & Okhuysen, 2009; Lamin & Zaheer, 2012; Sutton & Callahan, 1987; Tracey & Phillips, 2015), they have not examined the presence of multiple identities or of shared infrastructures. The presence of these two additional variables significantly limited how the Bitcoin entrepreneurs in this study could react to stigma. Thus, these findings are particularly relevant for an increasingly digital world, characterised by polarisation and competing identities, as well as shared digital infrastructures.

Entrepreneurial Heterogeneity

While code flexibility has previously been pointed to as a major reason for heterogeneity (Kallinikos et al., 2013), ideology has not. Here, the links between ideology, group membership and business model frame how and why an entrepreneur develops his or her business model in a particular direction, with emphasis on the type of service chosen and how customers are perceived. Moreover, these dynamics affect relationships between entrepreneurs and various stakeholders, with stigma being an extreme case that highlights them. For instance, owing to their ideologies the different firms attract different kinds of customers, meaning that "customer" became something fluid, depending on the perspective of the firm.

The same is true of ideological insiders and outsiders; as the spectrum of ideologies and their relationship to the five stigma mitigation strategies shows, stakeholders can be both insiders and outsiders relative to the stigma-experiencing organisations. A regulator may be an outsider for a Libertarian or Technologist firm, an insider for a Mainstream firm and neither for a Pragmatist firm (which cannot see a mercantile reason to either interact or not interact with the regulator). This heterogeneity and the exact dynamics whereby ideological heterogeneity leads to business model heterogeneity is deserving of further examination.

Having discussed our main theoretical contributions, we turn now to the practical implications of this work.

Practical Implications

The practical implications of this research are twofold. First, this paper outlines mechanisms that would-be entrepreneurs can emulate as they respond to stigma. Second, the paper points to the centrality of technology in stigma: where different sub-communities share a technology, differences in their ideologies and business models are not enough to insulate them from that stigma. Although this shared stigma does not make them rally together, it does mean that they rely upon each other despite ideological differences.

When it comes to the stigma mitigation strategies identified, we treat these as processes that multiple firms using a core technology may use to survive in the face of shared stigma. These strategies bear resemblance to those observed in previous studies, most notably when it comes to the drawing of insider/outsider boundaries (Hudson & Okhuysen, 2009; Tracey & Phillips, 2015) and attempts by firms to divest themselves of as much of the link to the stigma as possible (Durand & Vergne, 2014). However, by teasing out the underlying processes whereby these strategies are formed, we also provide empirical guidance for future open entrepreneurs as they respond to stigma. Moreover, while previous studies have been undertaken in established industries with a non-digital character (Devers et al., 2009; Durand & Vergne, 2014; Hudson & Okhuysen, 2009; Lamin & Zaheer, 2012; Sutton & Callahan, 1987; Tracey & Phillips, 2015), these findings are particularly relevant for our increasingly digital world.

Moreover, other entrepreneurs could use this framework, which demonstrates how open entrepreneurs in the context of Bitcoin came to the stigma mitigation responses that they did, in their own ventures. Some likely possibilities are 1) guidance in what to consider, and why, when forming a stigma mitigation response; and 2) anticipating how other stakeholders might respond to stigma and, in so doing, adjust their stigma responses accordingly.

When it comes to the core technology, and the resulting stigmatisation, the importance of the technology for business and social interactions is highlighted. On a practical level, the centrality of this technology means that entrepreneurs need not only respond to the social consequences of the stigma (as would be the case with stigma by association (Sutton & Callahan, 1987), but also embrace, at least to some degree, that the stigmatised technology is a core part of their business—and therefore unavoidable. Embracing this core stigmatisation may mean engaging with opposition stakeholders more often than they otherwise might, or enabling a more efficient use of resources, given the futility of trying to insulate oneself from the stigma completely.

In summary, these findings show the importance of both ideology and a shared underlying infrastructure in open entrepreneurship. While ideology triggers a number of processes among open entrepreneurs that allows them to respond to stigma, the shared infrastructure "anchors" the entrepreneurs to the infrastructure and OS community. This limits the extent to which these entrepreneurs can distance themselves from one another.

Lastly, these findings demonstrate how the accessibility of open source software allows open entrepreneurs to be ideologically heterogeneous, while relying on the underlying OS software.

Conclusion and Directions for Future Research

This paper contributes to our understanding of open entrepreneurs, shared infrastructures and stigma. By examining the role of ideology and group formation, we found that an OS infrastructure, by virtue of its infrastructural nature, anchored entrepreneurs—limiting the extent to which they could distance themselves from the infrastructure and the underlying OS community. This research builds on open entrepreneurship which pointed to knowledge (Dahlander & O'Mahony, 2011; Wallin & Von Krogh, 2010) and social capital (Yetis-Larsson et al., 2015) as reasons for OS community members to cooperate with one another. It further shows how Bitcoin entrepreneurs can build strategically important boundaries and cooperate with outsiders as a response to stigma (Devers et al., 2009; Durand & Vergne, 2014; Hudson & Okhuysen, 2009; Tracey & Phillips, 2015), without jeopardising their community membership.

Although we believe that this inductive study of digital entrepreneurs sheds light on our understanding of the dynamic between ideology and responses to stigma, as well as open entrepreneurs' local contexts and digital contexts, we are

also aware of the limitations of this work. In particular, we focussed on a single open source community, although within multiple contexts. At the time of writing, all but two of the firms interviewed were still operational, suggesting that these strategies have afforded the firms some staying power. The two firms that closed down did so during a period when the Bitcoin exchange price was low, and argued that they had financial problems as a result. It therefore does not seem as though stigma had a direct impact on their business operations. However, these strategies may still be inadequate to ensure long-term survival in the face of stigma.

We suggest that some areas for future research include broader examinations of the "anchor" role of digital infrastructures in both online and offline groups. The importance of ideology may, for instance, have rendered the infrastructure more important in this case than it might have been in other cases.

Second, we welcome an examination of the application of these group identity processes in online communities. While ideology and group identification have been seen in communities before (Fang & Neufeld, 2009), their importance in driving actions in an increasingly polarised online world makes this an area ripe for study. Lastly, we recommend further research into stigma mitigation: although the mechanisms of group membership *identification*, stigma *interpretation,* business model *enactment,* and response *salience* are clear, the circumstances in which they might vary, beyond variations in ideology and group membership, remain to be explored.

Chapter 5

Platform Use Takes More than Trust: Designed Legitimacy on a Crowdfunding Platform[17]

[17] First author, co-authored with Robin Teigland of the Stockholm School of Economics, and Emmanuelle Vaast of McGill University. Conditionally accepted at the European Journal of Information Systems

Abstract

Platforms, similar to entrepreneurs, typically face the liability of newness when they are first launched, thereby limiting their ability to attract users and obtain resources, which can ultimately affect their growth and success. Overcoming this liability of newness typically requires building legitimacy. However, legitimacy is something that is generally thought of as being embedded within a social relationship; that is, one that a platform based on digital artefacts may struggle to have.

This paper examines an attempt by a crowdfunding startup to gain legitimacy. Based on our qualitative research, we develop the concept of "designed legitimacy", and we argue that, at a minimum, a platform may be seen as *not* legitimate, implying that designed legitimacy is possible. We also point to the importance of gaining legitimacy, in addition to trust, for platform adoption. We further highlight the means through which a platform may come to be seen as legitimate, namely by designing with legitimacy in mind: by using symbols in design, asymmetric legitimacy-building, and two-stage legitimacy-building. We end the paper with propositions for further study.

Keywords: Entrepreneurship, Qualitative Research, Platforms, Legitimacy, Crowdfunding

Introduction

Overcoming the "liability of newness" is one of the major hurdles a startup firm has to overcome (Suchman, 1995; Zimmerman & Zeitz, 2002). This lack of legitimacy reveals itself in a startup's inability to rally resources in the form of financial, human and social capital (Suchman, 1995). In the platform economy, this lack of legitimacy manifests itself in a struggle by the platform to attract potential users to use the platform's services (Evans, 2009). This is in contrast to how one typically thinks of legitimacy - as being embedded within or the result of a *social* relationship between actors (Deephouse & Suchman, 2008).

With the rise of web-based platform ecosystems, the question of whether, and how, a platform can gain legitimacy is a timely one. Some of the largest platforms today have been valued at billions of dollars. Apple's iStore platform, for instance, saw users spend over 20 billion USD in 2015. These platforms start off small, with few users, but owing to network effects, once established, users are unlikely to switch to another platform (Koufaris & Hampton-Sosa, 2004). As with any venture, building legitimacy is key to attracting users. The primary difference between a platform-based startup and traditional startups is that the platform communicates with its potential users largely through its digital presence (Gawer & Cusumano, 2014). Platforms, like many digital artefacts, have already been found to optimize their appearance for their intended user groups. Wheelwright and Clark (1992), for instance, point out that modifying, adding, or subtracting different features can affect how a platform is received by different user groups. This suggests that design and communication are important for a platform's legitimacy and subsequent adoption. However there is limited research as to whether a platform itself can be considered legitimate and, if so, how.

A related question is whether this legitimacy-building through digital platform design relies on the same processes as legitimacy-building in non-digital contexts. Many platforms are multi-sided. In other words they have to appeal to multiple user groups simultaneously (Evans, 2009; Gawer & Cusumano, 2014) in what has been called a "chicken and egg" game. Building a market on one side of the platform often requires the existence of a market on the other side of the platform, and vice versa. How does this dynamic then affect designing legitimacy into a platform, if it is even possible?

This paper examines this issue of legitimacy-building by a multi-sided platform and is based on a study of a fast-growing crowdfunding platform in Stockholm, Sweden. More specifically, the crowdfunding platform was a two-sided platform offering investment possibilities to potential funders, on the one side, and entrepreneurs on the other side, through donation- and reward-based crowdfunding. In particular, the crowdfunding platform targeted information technology (IT) entrepreneurs, who were active early adopters in the Stockholm context. To conduct our study, we did not enter the field with a specific body of literature or theoretical contribution in mind. Rather we moved gradually towards bodies of literature after iterative open coding of our data from interviewing 29 people to answer our overarching research question:

> How can a two-sided crowdfunding platform gain legitimacy?

This paper is organised as follows. First, we discuss the concept of legitimacy and examine whether and how a digital platform can, conceptually, be seen as legitimate. Second, we delve into our research context and methods. We then turn to discussing our findings before presenting the implications of this initial failed attempt at designed legitimacy and a set of propositions for future studies of platforms and legitimacy-building.

Theoretical Background

From Trust to Legitimacy

We often discuss technological artefacts as having social, or human, characteristics (Benbasat & Wang, 2005; Corritore, Kracher, & Wiedenbeck, 2003). However, whether they can take on relational characteristics is not clear. Legitimacy, for instance, is typically seen as a social, relational characteristic and, by implication, one that can only arise between humans or among groups of humans (Suchman, 1995; Weber, 1978; Zimmerman & Zeitz, 2002). How then, if at all, can a platform gain legitimacy?

The concept of trust once faced a similar *impasse*. It was widely accepted to be a pre-condition for a piece of technology to be adopted (Gefen, Karahanna, & Straub, 2003), but most studies had looked at trust *in* the humans behind the technologies, rather than considering trust in the technologies themselves. This is because trust, like legitimacy, was thought of as arising within an interpersonal relationship between humans (Sztompka, 1999), and one that required conscious-

ness and agency (Friedman, Khan Jr, & Howe, 2000). However, research in information systems has shown how it is possible, both conceptually and in practice, for people to trust or even distrust a digital artefact (Benbasat & Wang, 2005). This is not least because people do, in fact, treat computers and other digital artefacts as though they are more human than simple tools (Reeves & Nass, 1996). In a study of the use of human rituals being used by machines (e.g., small talk), Cassell and Bickmore (2000) went so far as to say that trust included elements of both benevolence and credibility.

While studies of trust, and that of Benbasat and Wang (2005) in particular, provide a blueprint for how people develop a human-like relationship with a digital artefact, the nature of the relationship between people and the digital artefact in the context of trust is not the same as the nature of relationship in the context of legitimacy. Trust is defined as the willingness to take a risk (Mayer, Davis, & Schoorman, 1995), where an actor bears some responsibility (Muir & Moray, 1996). Trust in this conception is about the relationship between actors. Although it may be affected by context or social conventions (Cassell & Bickmore, 2000), it is largely about believing that an actor can, and will, do that which it says it will. In contrast, legitimacy looks at an actor through the lens of broader social expectations: "every goal, mean, resource, and control system is necessary, specified, complete, and without alternative" (Meyer & Scott, 1983: 201). Indeed, while trust might be said to be a *necessary* condition for a platform to be used, the legitimacy literature suggests that trust on its own may not be sufficient for users to adopt a platform (Garud et al., 2014; Suddaby & Greenwood, 2005; Zimmerman & Zeitz, 2002).

Digital Artefacts and Legitimacy

Legitimacy is best known from sociological theory, and from Weber in particular, who argued that legitimacy stemmed from conformity with both social norms and specific laws produced by hierarchical bureaucracies governed by human agents (Weber, 1978). This conception was further refined by Meyer and Rowan to show how "organizations structurally reflect socially constructed reality" (1977: 47) with legitimacy resulting from their desire to pursue effectiveness (pragmatic legitimacy), in line with legal mandates (socio-political legitimacy) and collectively valued goals, means and purposes (normative legitimacy). Ashforth and Gibbs (Ashforth & Gibbs, 1990) point out specifically that effectiveness and performance are not enough—*normative* compliance is necessary. Of note are the cognitive elements implicit in this conception on the part of the person perceiving the legitimacy (but not necessarily on the part of the organisation itself). Specifically, Deephouse and

Suchman refer to the importance of "explanation, theorization, and the incomprehensibility of alternatives" in studies of legitimacy (2008: 574). Although an organisation, or other entity, is said to be able to build legitimacy (Ashforth & Gibbs, 1990; Zimmerman & Zeitz, 2002), the implication is that this is not a necessary pre-condition for being considered legitimate. Ultimately, being legitimate rests on being *perceived* as such by other societal actors.[18]

When operating in digital spaces (Davidson & Vaast, 2010; Nambisan, 2016), a lack of legitimacy may be because the technologies upon which an agent relies have not yet received widespread acceptance (van Lente, 2012) or because they operate from the periphery of a field (Henfridsson & Yoo, 2014; Wright & Zammuto, 2013). However, the inability to obtain legitimacy may be the result of something more simple: the failure to conform to certain normative, structural and cognitive norms within a field (Suchman, 1995). While the boundaries of a field are hard to define, social theorists acknowledge that they may be characterised by multiple sets of social realities (Meyer & Rowan, 1977). Multi-sided platforms by definition exist to cater to multiple user groups, so it is not surprising that the perception of legitimacy differs among these groups. Despite this plurality of social realities, attracting one or more of these key user groups remains an important part of a multi-sided platform's strategy (Evans, 2003).[19]

The use of symbols, narratives, and the material to indicate this conformance have elsewhere been linked to legitimacy building and institutional change, most notably in the way in which language and semantics are used (Garud et al., 2014; Martens et al., 2007), and in the case of infrastructure (de Vaujany & Vaast, 2014). Moreover, Garud et al. (2014) find that narratives and stories articulated in the pursuit of legitimacy may themselves create new constraints or barriers to obtaining legitimacy. However, these symbols and narratives are typically employed by a human actor or organisation. Indeed, legitimacy is not something that has been attributed to a technological artefact as it is a *social* practice (Deephouse & Suchman, 2008).

[18] Consequently, legitimacy is heavily context-dependent. This poses a challenge for the generalisability of a study of legitimacy when it comes to a phenomenon like crowdfunding. Understanding some of the underlying dynamics whereby legitimacy is obtained, even if its normative content differs, may aid in future theorising around platforms, if not around legitimacy. We thank one of EJIS's reviewers for this subtle point.

[19] Thank you to one of our reviewers for pointing out the challenges involved in being seen as legitimate when one has to appeal to user groups that are likely to have a plurality of social realities.

Two-Sided Digital Platforms and Legitimacy

Two-sided platforms are a particular kind of digital artefact and have begun to attract attention, both for the ecosystems that they create (Tiwana et al., 2010) and for their efficient allocation of resources (Bakos & Katsamakas, 2008; Parker & Alstyne, 2012). Such platforms are typically seen as intermediaries; they connect two or more markets, and perhaps play some role in price-setting between the two sides (Rochet & Tirole, 2004). In the case of crowdfunding, they do so by reducing so-called information and transaction costs incurred by both entrepreneurs and funders as they screen and identify one another (Eisenmann et al., 2011; Rochet & Tirole, 2004).

Other platforms of interest for IS and innovation scholars have been those used for product innovation (e.g., Gawer & Cusumano, 2014; Parker & Alstyne, 2012) and supply chain management (e.g., Zirpoli & Becker, 2008; Caputo & Zirpoli, 2002). This platform centricity is notable among users of mobile devices and gaming consoles (Tiwana et al., 2010). Such platforms are defined as being comprised of two elements: an extensible codebase that provides core functions and modules that can be added or subtracted to add functionality. Collectively, these are referred to as a platform ecosystem (Cusumano & Gawer, 2002; Tiwana et al., 2010). These platforms provide an infrastructure that allows heterogeneous users to connect to one another (Rochet & Tirole, 2003) and, in so doing, lower the barriers to entry for those wishing to obtain resources (Eaton et al., 2015).

Platform ecosystems are said to be more dynamic than often imagined (Katz & Shapiro, 1994), and the context can often be influential in affecting whether a platform is adopted, how it is perceived, and what it is ultimately used for (Eaton et al., 2015; Tiwana et al., 2010). Platforms are a complex undertaking when the intended user groups are multiple, giving rise to what Gawer and Cusumano call a "chicken and egg" game of how to attract distinct groups of buyers and sellers to a platform (2014). Evans (2009) finds that, in the case of tire manufacturers, platform design is just one—albeit an important one—of the variables that drive adoption, and that context is similarly important. As legitimacy is a context-driven perception, we argue that it is not only possible for a platform to be perceived as legitimate, but that this perception is a vital part of platform design and commercialisation that has hitherto been neglected.

We now turn to discussing our research context, data and methods, before presenting our findings.

Context, Data and Methods

Research Design and Setting

We relied on the qualitative, theory-building single case study method (Yin, 2003, 1981) in designing and conducting our research. We began with an empirical problem, namely why crowdfunding was not being adopted by Swedish IT entrepreneurs, despite its adoption by similar groups elsewhere in the world, and the importance of startup-financing for entrepreneurs (Erikson, 2002; Kerr, Lerner, & Schoar, 2014). This study started as an exploratory one, and then zoomed in on the question of platform legitimacy as both an empirically and theoretically rich concept to explore—and one with particular relevance here.

Our research centres on a crowdfunding platform and group of actors in the startup community in Stockholm, Sweden, a city known as an IT entrepreneurship hub (Cheshire, 2011). A number of successful software companies, for instance Spotify, King and Skype, have emerged from this city in recent years. In late 2012 it also boasted a small number of crowdfunding platforms catering to entrepreneurs, including to IT entrepreneurs. The presence of a high technology startup community, high levels of internet connectivity in the country (over 90 percent in 2016, Davidsson & Findahl, 2016), and the fact that professional financing is hard to find in Sweden (Avdeitchikova, 2008) means that crowdfunding should be an interesting possibility for IT entrepreneurs within this community. In this paper, we refer to professional financiers as investors and those who invest using crowdfunding as funders.

Crowdfunding provides an interesting context for us to examine the concept of platform legitimacy as two-sided platforms are at the core of their operations. In crowdfunding, a two-sided platform can operate in four ways: 1) donation-based crowdfunding, where the crowd gives money as a donation and receives only intangible benefits in return; 2) reward-based crowdfunding, where the crowd gives money in exchange for a symbolic reward, product prototype or other tangible reward; 3) equity-based crowdfunding, where the crowd invests money in a firm in exchange for an equity share; and 4) debt-based crowdfunding, also known as peer-to-peer lending, where the crowd lends a firm money in exchange for interest on the amount invested and an eventual repayment of the capital amount (Belleflamme et al., 2014).

When we collected our data, the crowdfunding platform under examination was one of a small number of such platforms operating in Sweden. It started by offering donation- and reward-based crowdfunding, upon which we focused our

case study. Its offices were located in a co-working space with a number of other IT startups, and its employees and founders rubbed shoulders with other IT entrepreneurs on a daily basis. Given the physical closeness of the platform founders to a number of IT entrepreneurs (Porter, 1998, 2000), and the fact that IT entrepreneurs have raised funding on crowdfunding platforms elsewhere in the world (Mollick, 2014), we identified them as a key user group for this platform.

The platform later expanded operations to elsewhere in Europe and Asia and introduced equity-based and debt-based crowdfunding. Equity and debt-based crowdfunding are, today, the main focus of the platform. Other crowdfunding platforms present in Sweden catered to niche communities, e.g., creative arts, charity projects, while two platforms catered to Stockholm's IT entrepreneurs. The first of these is the subject of this study; the latter was a later entrant into the Swedish market and offered only equity-based crowdfunding but, at the time of data collection, had not yet raised any money in the country.

Data Collection and Analysis

We collected data through semi-structured interviews with 29 individuals, each lasting 30-75 minutes, which were recorded and transcribed. We made use of interviews in order to explore the apparent contradiction between the benefits of crowdfunding and IT entrepreneurs' failure to adopt it. We began by identifying IT entrepreneurs at the annual Swedish IT conference, "Internetdagarna 2012" ("Internet Days 2012") who self-identified themselves as looking for funding. We then relied on snowball sampling to identify other IT entrepreneurs and individuals in the field. Ultimately, our sample included IT entrepreneurs, platform founders, crowdfunding funders, venture capitalists, angel investors, and other interested third parties like businesses coaches (Table 14). The IT entrepreneurs were largely, but not entirely, entrepreneurs providing software, rather than hardware, as is common in Sweden (Andersson & Wictor, 2003; Casper & Whitley, 2004). In addition to interviews, we also collected data through 1) participant observations in meetings and conferences, informal meetings with numerous other entrepreneurs, and multiple interactions with funders and 2) extensive archival material such as from the crowdfunding platform websites and trade press analysis and documentation. This enabled us to look at the situation of crowdfunding for IT entrepreneurs in context and from their perspective (Graebner & Eisenhart, 2007; Suddaby, 2006).

After each interview we wrote notes around interesting themes that emerged from the interviews and later conducted data analysis using open coding of the interview transcriptions (Corbin & Strauss, 1990; Strong et al., 2014), triangulating

our findings against what we already knew about crowdfunding in the region from our social interactions and archival material.

Table 14: List of interviewees

Actor	Industry/Interests
Entrepreneur #1	Mobile questionnaire
Entrepreneur #2	Co-working space
Entrepreneur #3	Crowd sourced food data
Entrepreneur #4	Online education
Entrepreneur #5	Digital design agency
Entrepreneur #6	Online storyboard
Entrepreneur #7	Co-working space
Entrepreneur #8	Digital storytelling
Entrepreneur #9	Blog aggregation tool
Repeat Funder #1	Media industry
Institutional Actor #1	Business coach
Repeat Funder #2	Media and academia
Institutional Actor #2	Not-for-profit agency
Entrepreneur #10	Travel experience app
Entrepreneur #11	Clothing size simulator
Entrepreneur #12	Wifi-sharing app
Entrepreneur #13	Student competition site
Entrepreneur #14	Crowdfunded advertising
Platform #1	Equity-based site
Platform #2	Equity- and Reward-based site
Entrepreneur #15	Film producer
Venture Capital Investor	Large bank
Angel Investor #1	Invests in personal capacity
Platform #3	Crowdfunding site that closed down
Angel Investor #2	Invests as part of a group
Platform #2 (follow-up)	Equity- and Reward-based site
Platform #2 (follow-up)	Equity- and Reward-based site
Platform #2's designers	Digital design agency
Platform #1 (follow-up)	Equity-based site

During open coding, a number of themes began to emerge, and we stopped open coding when no new themes began to emerge (saturation). We then engaged in axial coding as a way to discover relationships and to explore the most plausible relationships between open codes in the data (Locke, 2001; Suddaby, 2006). We did not explore the data with a theoretical framework in mind, but rather we allowed meta-level themes to emerge from the data during the process of open coding (Strong et al., 2014; Suddaby, 2006). In this process, the theme of legitimacy, both with reference to the platform and the IT entrepreneurs' need to derive legitimacy from their choice of financing arose repeatedly. Similarly, the features of the

digital platform regularly arose as important in that they framed what the IT entrepreneurs perceived was possible using the platform, and thus whether the platform afforded them the legitimacy that they sought. After several iterations of coding, we found that our codes highlighted a problem of legitimacy – one that stemmed, in large part, from a gulf between the features built into the platform in question, the narratives used by the crowdfunding startup to convince IT entrepreneurs to use the platform, and the uses the IT entrepreneurs ultimately perceived as possible through the platform.

The prevalence of the IT entrepreneurs' interpretations was validated through our interviews with other actors in the field not directly involved in crowdfunding (such as business coaches) as well as by following up informally with those interviewed to ensure that we had accurately understood their comments. This process led us to understand how IT entrepreneurs did not perceive the crowdfunding platform as affording them with what they needed (i.e., not just financial resources but also the legitimacy that came from getting funding from established, professional investors), contrary to what the platform founders expected when they had designed the platform. This, in turn, affected the platform's ability to become seen as legitimate. We expand upon these findings below.

Empirical Findings

Our findings indicate, as earlier suggested, that the platform founders, themselves entrepreneurs, were aware that they were not yet "taken for granted" in the field in which they found themselves. They were competing in an established and mature field, characterized by clear roles and responsibilities for entrepreneurs and investors, whether business angels or venture capitalists, as well as a clear flow of resources between these actors. Further, the design of their platform did little to enable similar relationships in the digital realm.

Norms and Expectations around Financing

As with any mature field, the investment landscape in Stockholm was well-established when this crowdfunding platform entered the scene. There were established norms around how financiers and entrepreneurs should behave as well as the relationships between the two. The norms in this field included the idea that investors be well-informed professionals who closely scrutinised an entrepreneurial firm before investing, and who invested social and human capital in a firm, not just financial capital. Moreover, entrepreneurs could choose which investors to ap-

proach, and both parties exerted some control over the investment process. These investment relationships were deliberate, long-lasting and described as relying on extensive prior screening by both investors and IT entrepreneurs.

The norms around professional equity investments were the most prominent, and while the crowdfunding platform did not (at the time) offer equity investment, the entrepreneurs naturally compared the two. This obvious comparison was reinforced by the platform's own narrative that it was a "substitute" for other forms of financing.

The single most important thing that entrepreneurs sought to obtain from a potential investor was a stamp of approval through recognition of both the team and the firm's product or service. Entrepreneurs argued the decision to invest was based on a close examination of the firm's idea, team, and business model by an informed professional:

> We weren't really at the time able to show that we actually lowered returns and increased conversion. It's hard to get all these stats right – but we had some sort of proof of concept and the seed funding ended up, kind of like, [coming from] a mixture between professional and angels (Entrepreneur #11)

The IT entrepreneur could therefore treat an investor's decision to invest as a signal to others in the field: that his or her firm was going in the right direction – and had growth potential. This stamp of approval was particularly visible in professional investors' tendency to invest their time and expertise in a young firm, typically by sitting on the firm's board and giving the firm advice (human capital):

> In particular we, either I or someone in the team, is an active board member… we (also) try to help with hiring management, you have to do some firing sometimes as well, some restructuring of boards and management teams to meet with new challenges that the venture needs after a few years. (Venture Capital investor)

Having a known professional investor on a firm's board also said something about the firm's trajectory moving forward. Not only had it attracted a professional investor, but his or her ongoing involvement signalled that the firm was likely to grow and become profitable (social capital):

> It's not just about money. It's about getting a name into the boardroom. It's a game of illusions… [which shows that] we are going somewhere because this guy or woman is endorsing us (Institutional Actor #2)

Moreover, these relationships entailed reciprocity. For investors, investing in a firm that subsequently became a "big" name or made large profits through an "ex-

it" was key to showing other firms—and investment clients—that they were skilled at their jobs. Moreover, this relationship was mutually beneficial and continued beyond the first investment. It was one that continued for many years as the venture grew and matured, and investors often re-invested in the firm, or introduced firm leadership to investors who would. This allowed the entrepreneurs to make connections that were otherwise difficult to make in a country with flat hierarchies and tight social networks:

> Sweden, I noticed, is a lot, like, relationship based: it's not that kind of you know you have to have a personal relationship, but they have to have heard about you before, like, somewhere [to invest]. (Entrepreneur #3)

Furthermore, implicit in this relationship is the idea that both the entrepreneurs and the investors saw the investment process as one that was clearly defined and tightly controlled (what we have called "exclusive"). That is, few people could do it well and competition for resources was stiff, but, when it occurred, the clear process signalled the value of the firm and the idea:

> I kind of feel that if you can't get, like, if you can't get money from investors, you're doing something wrong. (Entrepreneur #12)

Tensions Between the Platform and Pre-Existing Norms

In contrast, the crowdfunding platform was not designed to be exclusive. The platform founders, in building their platform, explained that the features of the platform had been influenced by e-commerce platforms and social networking sites. Indeed, they believed that the use of a fun, social, and inclusive approach to raising funding would be welcomed by entrepreneurs, among them IT entrepreneurs, and would provide entrepreneurs with an alternative source of funding. Making the platform "inclusive", and thus open and attractive to funders beyond traditional, professional ones was part of this strategy:

> The concept of crowdfunding means that you can reach across the globe within seconds, thanks to social media and engage people that are willing to give you money or willing to back you or willing to take that chance in order to make things happen (Platform #2, first interview)

Inclusivity and a Focus on "Selling" Entrepreneurs' Ideas

The overarching understanding of this platform is understood through an examination of its features. When a user clicked through from the platform landing page to see an individual project, the most prominent feature on the project page was a large "Fund this project" button in the centre of the page. Around it were the project's title, a brief project description, an image or film clip describing the project, and a range of social media icons for a user to share the project with his or her social networks. Below the central button were three tabs, and by default the user landed on the "Project overview" tab. The alternate tabs were "Backers", or the number of funders, and a "Flag this project" tab in order for a user to easily report concerns around the project (Appendix Five).

Beneath the project overview was a comments section in which anyone—whether a funder or curious website visitor—could comment and ask questions about the project. To the right of the page was a bar that tracked the percentage of total funding obtained, the value of the funding obtained (in SEK or EUR) and the time left for the project to receive funding, along with the rewards offered for this particular project. Additionally, scrolling to the bottom again presented the website user with a "Submit your project" button above the bottom menu.

Possible funders were not the subject of much attention on the platform. Beyond an alias, the funders were not required to provide any information about themselves – although some did voluntarily. The backers tab, the second of the three tabs mentioned above, takes the viewer to a list of funders. However, the list contained little information about the backers beyond their aliases and, when they have one, an identifying image. This view of the funder as an anonymous individual, rather than a savvy investor, contrasts with the exclusive and legitimacy-bearing relationship that the IT entrepreneurs looked for when choosing an investor.

This design points to the idea that raising money from a diverse group of individuals was the primary purpose of the platform. Next, the entrepreneur and his/her project were emphasised on the platform. However, the identities and offerings of potential funders were clearly far less important, showing the platform's asymmetric focus. In particular, the platform primarily provided a platform upon which the (IT) entrepreneurs could market a one-off project. It did not focus on anything related to the funder, beyond the money he or she invests in the project. Indeed, the platform founders believed that the platform should attract non-professional funders:

> Our main goal is two years from now, that lady down there, to get her to say 'I really love ice cream, where do I go to buy into an ice cream company?' And then we want

> [the platform] to be on her tongue and for her to say 'Hey, I should look towards a crowdfunding platform and see if I can become an investor in an ice-cream shop'. Because you can't do that today. (Platform #2, first interview)

As such, the features of the platform provided no information about who potential funders or actual funders were – reinforcing the perception that they are an anonymous "crowd."

While IT entrepreneurs acknowledged that they could raise small amounts of money through crowdfunding platforms, they suggested that they could not raise "smart" money since mostly ordinary people—not qualified, savvy investors—would contribute through the platform. Moreover, Sweden's small population meant that they were unlikely to raise large sums this way. This was reinforced by Swedes' belief that the high taxes they paid meant that the state should support charitable causes on their behalf. Those who invested via a crowdfunding platform were therefore seen by IT entrepreneurs as unable to judge the value of a project. Their investments—both in size and through the lack of demonstrable investor skill—therefore did not signal quality or competence. The inclusivity of the platform, combined with the fact that the IT entrepreneurs could not screen potential funders, deterred them from using the platform. Indeed, the lack of investor skill made entrepreneurs feel like they were asking for charity rather than investment:

> You basically go out to people without any investment experience, without any knowledge of how to rank or value the start-up, and you ask them [for money]… if you have a decent idea you should be able to get an investor that can do proper due diligence and that can actually get excited about the idea to add some value and not get random people on the street to invest. (Entrepreneur #11)

One-Off Transactions, Reminiscent of E-Commerce (Or Charity)

The design of the crowdfunding platform's functions was reminiscent of e-commerce sites in its focus on issues such as simplicity and speed of purchase. The layout of an individual page modules was designed to make the process for a funder to choose and fund a project a relatively effortless one requiring only a few clicks, similar to buying any other product or service online – whether used clothing or spare bicycle parts. As one IT entrepreneur noted:

> I think that people are a bit self-conscious. It feels like they're bragging or something. Because in a way funding a project is a bit like buying a new handbag. It's just a different demographic. (Entrepreneur #2)

This observation apparently did not deter Entrepreneur 2, who together with her team, successfully raised financing through the platform in 2012.

This one-off transaction was not one that appealed to most entrepreneurs. An alternative use for crowdfunding, beyond investment, was for an IT entrepreneur to show to potential future investors that he/she is able to communicate well. This possibility emerged but was largely crowded out by the perception that a crowdfunding platform was a marketplace. However, it does indicate that the platform was trusted to deliver (small) amounts of financial capital, but not the other resources that IT entrepreneurs sought:

> So if I would have started this case or this project or company these days, I would definitely have looked into crowd funding, not mainly maybe because I think it, you know, could fully finance you, I wouldn't see that as the main reason for crowd funding. It will help you a bit with the finance but mainly I would use crowd funding to get attention, to get ambassadors. (Entrepreneur #8)

For professional investors, the fact that they had little control over crowdfunding processes and the lack of long-term influence over a project that had raised crowdfunding was a reason not to use the platform. They also trusted the crowdfunding platform to deliver on its promises, but reacted to their inability to control the process, and thus lose their power to influence the nascent firm's development. As one investor noted,

> A couple of crowdfunding projects have approached us, either as a sponsor or as an investor. And I've never taken that up, indeed because partly I feel that we don't believe enough in crowdfunding to be a sponsor… I'm afraid that our bank trademark could be used as a quality stamp and if we have no impact on the quality of the actual projects then we should not expose our trademark. (Venture Capital investor)

Although crowdfunding had the potential to draw attention to a project, the IT entrepreneurs did not think that this was enough reason to solicit funding through the platform. In fact, they noted obtaining financing though crowdfunding required considerable effort. Moreover, because of its inclusive nature, both investors and entrepreneurs felt that they had very little control over the process, as noted above. The feature enabling users to share a project within their social networks meant that the firm's ideas were spread to anyone anywhere online, and funding from a specific individual could not be rejected. Other IT entrepreneurs observed that the crowdfunding platform itself did not attract or generate attention on its own. Instead, those entrepreneurs who had used crowdfunding argued that in order to succeed at crowdfunding, a project had to have built a community *prior* to undertaking a crowdfunding campaign:

> We started to build a community like six months before via Facebook, started a community page, started to reach out and started to do all of this small stuff. And when we actually started the crowdfunding campaign we already had a community of say 400 people that we were already daily talking to, on a daily basis. So that was hugely facilitating because people were like eager for something to happen and then we could just like oh guys now we're on [platform] so people could give 100 SEK or more. And people gave like 10 000 SEK. (Entrepreneur #2)

In summary, the investment norms in this field treated investment as involving the transfer of financial, human and social capital from a professional, informed investor to a new firm. Transfer of these resources occurred after a controlled, exclusive process that involved close scrutiny. Receiving them was a signal to other firms and investors of the value of the entrepreneurs' team and idea. Obtaining investment in this way provided critical early-stage legitimacy, which was thought to pave the way to obtaining further resources later, whether from the initial investor or through that person's network.

In contrast, crowdfunding was seen as one-off, and entrepreneurs did not see the potential to enter into a long-term relationship with potential funders. While entrepreneurs and investors trusted the platform to deliver on its promises, they disliked that they could not control the fundraising process through screening potential funders or limiting who had access to their business idea. The transaction was instead seen as one-off and reminiscent of e-commerce, which made entrepreneurs think that they had to have something to sell, rather than for funders to invest in.

An (Il)Legitimate Form of Financing

These one-off transactions, conducted with funders who were anonymous and who could not be screened were seen as typical of crowdfunding. Although entrepreneurs acknowledged that there was some money to be raised through crowdfunding and they did not distrust the platform, they nevertheless did not see it as conforming to the norms around investment in the field. These norms and expectations, and the corresponding platform features, are summarised in Table 15.

Having discussed the stumbling block that led to the entrepreneurs seeing the platform as being trustworthy but not legitimate in the sense of conforming to existing norms and expectations around investment, we now turn to a discussion of the implications of these findings.

Table 15: Investment expectations among IT entrepreneurs and corresponding platform features

	Professional investment norms	**Crowdfunding perceptions**	**Corresponding platform feature**	**Illustrative quotations**
Intangible signals of legitimacy	Strict screening meant investment was "stamp of approval" Success signaled legitimacy to others Investors known, screened by entrepreneurs and vice versa	Funders seen as inexperienced/ unprofessional – so investment not a signal Once-off exchange so no reputation effects No option for entrepreneurs to choose funders	Donation/funding decision automated Funders not obliged to identify themselves No feature to reject donations /investments Resembles e-commerce	*It also depends on how it's sold, because crowdfunding is selling. You sell a company like how you sell a product. You can have two exactly the same companies, it's just the one has the knowledge of how to sell something that will win.* (Entrep. #9) *As I understand it it's a bunch of different guys, maybe one person invests a lot, but it still feels kind of too random.* (Entrep. #11) *If you can't get money from investors, you're doing something wrong. I mean, investors, I mean, some of them are asses. Some of them are very harsh. But, there are quite a lot of investors that if you're, if you're at least semi-good, you should be able to get an investor that does proper due diligence and sees some form of possibility to invest.* (Entrep. #12)
Tangible signals of legitimacy: **Financial capital**	Relatively large amounts Possibility of repeat investment	Relatively small amounts One-off investment Elements of charity, rather than investment	"Fund this project" button Bar tracking funding progress	*I think Swedes donate less to charity than American people do because of paying more taxes and in general people don't pay forward to universities, etc. So, I think, crowdfunding will take longer in Sweden to get established, if ever.* (Entrep. #13) *And also it's a bit strategic... We really wanted to be strategic about our funding. You want to bring an investor in and know that this investor can put in more money if you need.* (Entrep. #11)

Tangible signals of legitimacy: Human and social capital	Involvement on Board/ as Advisor Access to networks Long-term relationship and involvement Exclusivity/ some control over process	Access to ambassadors Social media engagement Short-term relationship (perhaps even once-off) Inclusivity / lack of control over process	Project description Social media icons Symbolic investment Resulting rewards Possible to comment / report project Finite project period Open call	*…I also think a disadvantage could be the uncertainty that you give your idea out and it's out there for many months, someone can, people can also get inspired, people with better connections can then start creating something similar at the same time.* (Entrep. #4) *Crowdfunding publicity by buying commercial space and making publicity there for your cause actually solves that whole issue [of journalists representing their communities views]… it has this wonderful way of making itself relevant and if you don't collect enough money, then your cause probably isn't relevant and shouldn't have the limelight, pretty much.* (Entrep. #14)

Discussion and Theoretical Development

As we found through our research, the crowdfunding platform not only initially had no legitimacy among IT entrepreneurs, but also failed to gain the perception of legitimacy among this key potential user group over time. This was due to its failure to conform, either passively or strategically, to existing norms around entrepreneurial finance (Suchman, 1995; Tornikoski & Newbert, 2007). We find that this was because the platform needed to provide legitimacy and social and human capital—in addition to financial capital—in order to itself be considered legitimate. The fact that IT entrepreneurs trusted the platform was not sufficient for them to use it; legitimacy was also required. Below we introduce and substantiate the concept of "designed legitimacy", building upon the observation that the platform was compared to other, legitimate, actors. We also discuss the implications of these findings and generate propositions for future research.

Trust and the Designed Legitimacy of a Digital Artefact

The single clearest finding in this study is that the crowdfunding platform was capable of *not* having legitimacy. For clarity's sake, this is not the same thing as not being *able* to have legitimacy. In this case, the entrepreneurs in question assessed the viability of the platform's offerings in line with their expectations of a funder and found it lacking in a number of ways, many of which are to do with its design as a platform.

Designed legitimacy requires designing an artefact that, by virtue of its design, is compliant with key actors' normative expectations in the field. It entails strategic legitimacy-building (Suchman, 1995) in that the features of the platform, and associated narratives, need to be presented as consistent with existing norms in order to attract key actors. While our data points to the importance of designed legitimacy among crowdfunding platforms, as crowdfunding platforms are a type two-sided platform that creates a marketplace, it is likely that this concept, and the propositions that follow, apply equally to other kinds of two-sided platforms. While the normative content of legitimacy is content-specific, strategic legitimacy-building is commonplace where two-sided platforms (especially crowdfunding and crowdsourcing platforms) enter fields with well-established norms. Thus, designed legitimacy may aid those seeking to build and commercialise platforms that behave as online matchmakers or intermediaries (Parker & Alstyne, 2012; Rochet & Tirole, 2003).

Trust and Normative Conformity

Existing literature has predicted that normative conformity can be a way for a new actor to obtain legitimacy (c.f. Barreto & Baden-Fuller, 2006; Deephouse, 1996; DiMaggio & Powell, 1983; Haveman, 1993). However, it has also been observed that normative changes can come from new actors operating from the periphery of a field (Battilana et al., 2009; Wright & Zammuto, 2013). This begs the question: while legitimacy has clearly been shown to be essential for attracting new users, which norms should be taken into account in the pursuit of legitimacy? Moreover, who are the key users when it comes to gaining legitimacy?

In our case, investment norms were well-established. They governed not only resource transfer but also legitimacy acquisition, notably between the users whom they sought to attract and the funders whom they sought to supplant (Figure 9A). Empirically, the fact that there were no uncertainties or problems with this established set of norms, suggests that conforming to existing norms is, at least at first, necessary. Thus, while potential users trusted the platform, this was not enough to encourage platform use. Incomplete compliance with these norms therefore undermined the platform's pursuit of legitimacy.

Trust has been seen to be for a platform to attract new users (Vance, Elie-Dit-Cosaque, & Straub, 2008), and it has been treated as sufficient to attract these users (Gefen et al., 2003). However, for IT entrepreneurs to use the platform in this case, the platform not only had to be trustworthy but also had to be seen as a legitimate source of funding by these users. Here, incomplete conformity—by trying to emulate a professional investor without being able to provide the same legitimacy as such an investor might—failed to build legitimacy. While previous research has pointed to the importance of trusting a platform to do what it says it will do (Benbasat & Wang, 2005; e.g. Gefen et al., 2008), this research suggests that a platform has to do what it says it will do *in the right way*. That is, in a way that is consistent with existing norms in the field around how to become—and remain—legitimate.

> Proposition 1: Two-sided (crowdfunding) platform adoption requires that a platform gain both trust and legitimacy by key user groups.

The ability of a platform to comply with these norms, and design such an experience for its users, also depends on which user groups it prioritises. Choosing this key user group is therefore as much a legitimacy question as it is a technical and operational one.

Figure 9: A comparison of the traditional entrepreneurial finance process with that of crowdfunding.

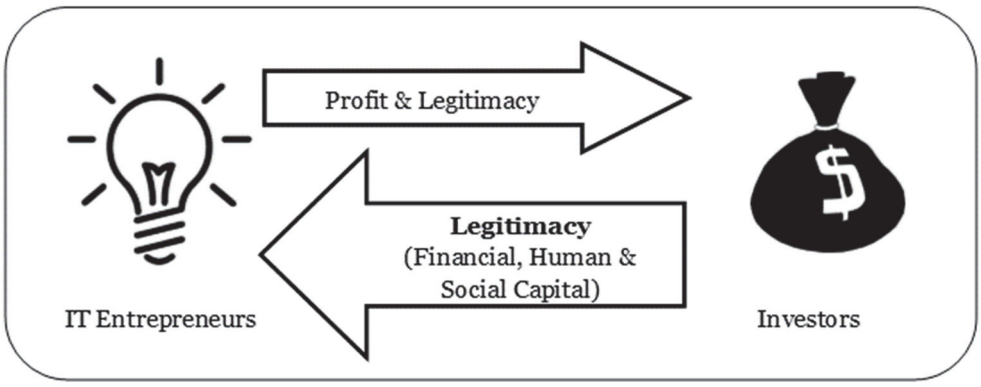


Figure A: The process of raising entrepreneurial finance according to existing field norms

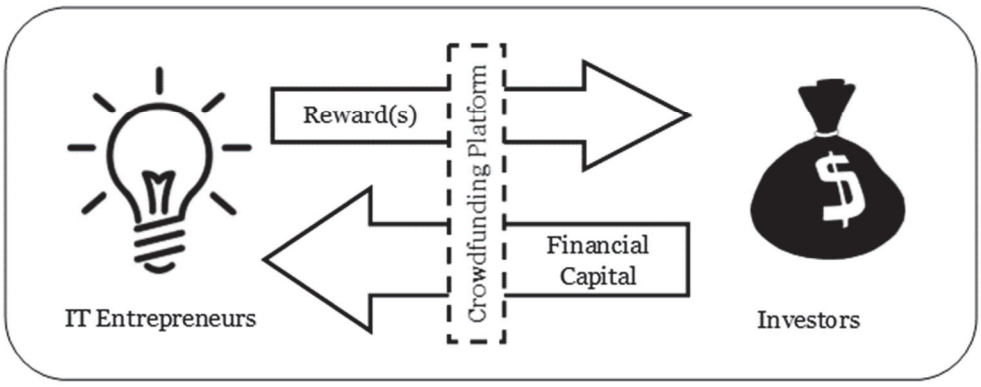


Figure B: The process of raising entrepreneurial finance using a crowdfunding platform

Which Users?

In our case, the platform included several users in its key user group. Among these were IT entrepreneurs, owing to their digital savviness and their close proximity to the platform founders. The platform was not designed to provide these key users with the same kind of resources as a typical investment relationship. However, that is not to say that it did not provide resources at all. It provided (small amounts of) financial capital, while typical investment relationships delivered some combination of financial, social and human capital. The comparison between the platform and this more human relationship indicates that the platform elicited the same kind of legitimacy assessment as an investor might, which suggests the possibility of designed legitimacy, even if the platform fell short in this case.

In the case of this crowdfunding platform, the platform's design did not provide an equivalent for the legitimacy that the actor they sought to replace, i.e., the professional financiers, ordinarily provided. Instead, the platform was designed to

do what is described in figure 9B, that is, facilitate the transfer of financial resources. This simple approach relied on an e-commerce-like platform and a narrative that framed the phenomenon as a *substitute* for existing sources of funding. This design was implemented without reflecting on the legitimacy needs of the actors they were trying to attract, in this case IT entrepreneurs. Instead, they focused on technical and operational requirements, and overlooked these normative ones.

In this case, one key user group failed to see the platform as legitimate—as the platform could not provide them with the legitimacy they themselves required. The idea that obtaining legitimacy may be contingent on other events or exchanges is one that has been recognised in previous research (Ahlstrom & Bruton, 2001; Dart, 2004). Garud et al. (2014) find that narratives and stories articulated in the pursuit of legitimacy may themselves create new constraints or barriers to obtaining legitimacy. The case at hand presented a similar paradox, albeit with a double loop effect. Here, obtaining legitimacy by the crowdfunding platform was contingent on being perceived by a key intended user group as providing them with legitimacy:

> Proposition 2: A two-sided (crowdfunding) platform derives legitimacy by itself providing legitimacy to a strategically chosen key user group.

By being unable to show IT entrepreneurs how they could gain legitimacy, the crowdfunding platform could not persuade them to use their service, and consequently could not be seen as legitimate in the eyes of these IT entrepreneurs. Platform design, in order to attract key users, needed to include normative conformity; the "build it and they will come" approach to design (Markus & Keil, 1994) did not work. Instead, attracting a key user group through design becomes a strategic decision that the platform founders need to make.

Pursuant to this line of thinking, we have developed further propositions around designed legitimacy on a platform, or the design of a platform to offer cognitive, structural and normative compliance with the norms in a field. Three possibilities present themselves, based on this case: the use of symbols and references in design, asymmetric legitimacy building, and multi-stage legitimacy building.

Designed Legitimacy

It is difficult to see how a platform might provide human and social capital in the same way as an investor might. At best it could form a *conduit* for these things, but this role is one that platforms are not known for. Instead, two- and multi-sided platforms are better known for price-setting and market transactions (Rochet &

Tirole, 2003; Rochet & Tirole, 2004), suggesting that although legitimacy may be theoretically possible, the critical elements needed to facilitate human and social capital flows, and thus legitimacy, need to be designed into a digital artefact.

Mimicry, Symbols and Legitimacy Building

In our case, legitimacy turned on the ability to screen potential investors and build a long-term relationship. One of the flaws of the design was that the platform was similar to an e-commerce platform, implying a one-off sale instead of a long-term investment. The platform therefore did not provide the possibility for repeated interactions or critical interaction. This feature could, however, be designed into the platform. This is consistent with earlier research around platform adoption, which posits that platform design affects whether, and how, people interact with it (Wheelwright & Clark, 1992).

One possible way for legitimacy to be built through a platform is through the use of symbols or symbolic design. It has been observed elsewhere that the use of symbols is often part of legitimacy-building (Stringfellow, Shaw, & Maclean, 2013; Zott & Huy, 2007), but the use of such symbols for legitimacy-building has never before been seen in the context of a designed IT artefact, nor, indeed, in the operations of the platform in question.

In this case, the platform did not make explicit use of symbols, but it did emphasise some possibilities over others through design, for instance by making the "fund this project" button more prominent than information about the project itself. By not requiring funders to provide information about themselves, and not displaying what little information was available prominently, the platform also de-emphasised that group of actors, to their detriment. Mimicking existing relationships and hierarchies through design elements would allow platform owners to passively be seen as legitimate.

> Proposition 3a: Designed legitimacy requires a strategic approach to legitimacy-building.

> Proposition 3b: A temporal relationship can be designed into a platform, which affects designed legitimacy.

> Proposition 3c: The placement of design elements creates a hierarchy of features, which affects designed legitimacy.

> Proposition 3d: The placement of design elements creates a hierarchy of actors, which affects designed legitimacy.

Asymmetry in Legitimacy Building

Taking this one step further, one intuitively thinks that a crowdfunding platform's designed legitimacy might entail gaining legitimacy from both entrepreneurs and potential funders, to the same extent. However, this paper also finds asymmetry in who was willing to use the crowdfunding platform (namely IT entrepreneurs), implying that encouraging one key user group over another may be of strategic important. Gaining legitimacy from these two groups therefore also requires strategic legitimacy-building through design.

Our initial impression was that gaining legitimacy relied, in the first instance, on being seen as legitimate by a key user group, in this case IT entrepreneurs in the Stockholm context. This was because without interesting and credible projects on the platform, the funders in question would not engage with the crowdfunding platform. However, the fact that the platform's features highlighted the entrepreneurs but not the funders deterred this latter user group from using the crowdfunding platform. This implies that the platform, in the pursuit of legitimacy, should emphasise both user groups in order to asymmetrically gain legitimacy for (and from) the IT entrepreneurs.

This strategically important way of designing legitimacy stems from the fact that the crowdfunding platform is operating in a field characterised by relationship-driven norms around financing. That is, norms that require that both parties be visible. In our study, the invisibility of the funders and backers meant that the IT entrepreneurs did not think that the platform could offer human or social capital.

While information asymmetries in legitimacy building are commonplace (Feldman & March, 1981; Mavlanova, Benbunan-Fich, & Koufaris, 2012), such symmetry in legitimacy-building has not yet been examined. Indeed, the notion of symmetry in design in order to asymmetrically gain legitimacy is counter-intuitive. Here, not only does the two-sided platform need to strategically design legitimacy, it needs to highlight multiple user groups on the platform in order to gain legitimacy among just one key user group. This is a consequence of the importance of relationships in the prevailing local context.

> Proposition 4: Designed legitimacy on a two-sided (crowdfunding) platform requires highlighting multiple user group, in order to gain legitimacy with the key user group.

Two-Stage Legitimacy Building

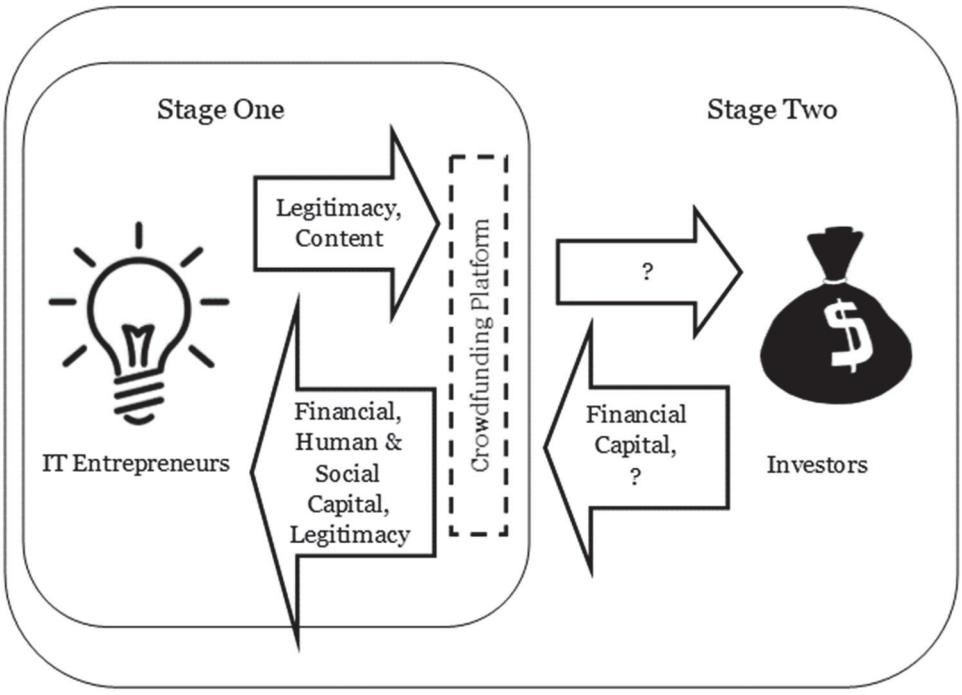
Additionally, such an approach might suggest that in the context of two-sided, or matchmaking, platforms, designed legitimacy might need to take a strategic two-

stage approach, focusing at first on one user group and then on the other. In this case, failure to be seen as legitimate by IT entrepreneurs meant that investors were not interested in the platform. This is because while designing for legitimacy initially relies on being *able* to offer legitimacy through platform features, attracting subsequent user groups may rely on the platform actually *having* that legitimacy.

Obtaining legitimacy with the second group would entail providing the first group with legitimacy, and thus being seen as legitimate themselves. Being perceived as legitimate by the second group would thus depend on obtaining legitimacy with the first. Based on this we present our fifth proposition and illustrate this process in Figure 10.

> Proposition 5: Two-stage legitimacy building can drive two-sided (crowdfunding) platform legitimacy.

Figure 10: Legitimacy acquisition by a crowdfunding platform in an asymmetric, and possibly two-stage, model.



Theoretical and empirical examinations have suggested that platforms, particularly two-sided platforms, are complex to design as both their features (Eaton et al., 2015; Tiwana et al., 2010) and the context in which potential users find themselves (Evans, 2009) influence how they are perceived by one, or both, sides of the platform. Indeed, we see here that strategic designed legitimacy is vital for legitimacy building.

Conclusion and Implications

Our case study revealed an unsuccessful attempt at legitimacy-building by a two-sided platform. Despite the fact that it was trusted, its initial failure to be perceived as legitimate stemmed largely from the IT entrepreneurs' (i.e., a key target user group) perception of the platform. Its features and the symbols that they evoked did not afford IT entrepreneurs investment possibilities that they saw as useful. We then derived propositions for further investigation based on these findings.

What these findings suggest for managers is that legitimacy itself is a resource that cannot be overlooked when examining the flow of resources within an established field. This is contrary to a widespread "build it and they will come" approach to IS design (e.g. Markus & Keil, 1994). Rather, it suggests that the operational and technical focus on building a product that fulfils a perceived need is not enough; that normative elements are also vital to a new platform's success.

When managers rely ona platform to enter an existing mature field, they need to consider that the overt flow of resources, such as financial capital, may only be part of the picture. Indeed, the relationships between parties may include legitimacy, as seen here, and attempts by the entrepreneurs behind the platform need to include an alternative source of legitimacy for the user group to which they are appealing.

These findings also indicate that it is possible for a platform to *not* be seen as legitimate. This is very promising for future studies of platform legitimacy and legitimacy building, and we suggest that it implies that platform legitimacy is similarly possible.

Moreover, framing and the use of symbols by the platform must be consistent with extant norms and mimic offline relationships. Where the two are inconsistent (or the mimicry incomplete), users struggle to ascertain which message to believe, which undermines the at the platform's ability to gain legitimacy.

Finally, one group of users may need to be prioritized first when it comes to providing this legitimacy; in this case it was the IT entrepreneurs. In any event, building a platform in the "build it and they will come" manner without considering that being seen as legitimate by one group of users may be a prerequisite for being seen as legitimate by other groups of users.

This research relied upon a single case study, which may limit the generalizability of our findings (Gibbert et al., 2008). However, this study points to the importance of strategic and normative compliance (despite the fact that their content is context-specific) in platform development; something that we think is deserving of further investigation.

Moreover, the entrepreneurs we interviewed were primarily producing software, rather than hardware, which may affect their perception of the phenomenon. The unique cultural context in which this study was conducted may also mean that it is not generalizable outside of Sweden, a country known for its flat hierarchies and tight social networks (Jonsson & Buhr, 2011; Landstrom, 1995). Future research could examine other contexts to see how empirically generalizable the findings are as well as to investigate further contingencies and asymmetries in the pursuit of legitimacy in multi-sided platforms.

With this research, we have taken a first step in understanding whether, and how, a platform can gain legitimacy. We also observe that trusting a platform is not always sufficient for adoption, but that legitimacy may pave the way to adoption. In our study we focused on a donation- and reward-based crowdfunding platform in Sweden, but our findings are likely to be generalizable to other crowdfunding, crowdsourcing and other matchmaking, or two-sided, platforms. In this case this was because being seen as legitimate was contingent on providing legitimacy to the platform's users. Moreover, the features and design of a platform, where they do not match the objectives of the user, can lead to a situation in which the platform in question is perceived as not being legitimate. Lastly, legitimacy building may require asymmetrical efforts even when a platform is two-sided. These theoretical contributions require further examination in different contexts and in taking account both sides of a two-sided platform. They pose unanswered questions around legitimacy and platforms for platform theorists and design science that are ripe for investigation.

Chapter 6

Coding For Collective Action: The Case of the Digital Economic Social Movement of Bitcoin[20]

[20] Authors contributed equally, co-authored with Jonas Valbjørn Andersen of the IT University of Copenhagen. Submitted to *Information & Organization's* Special Issue on Collective Action, Social Movements and Digital Technology.

Abstract

Technological solutions to perceived social problems have received considerable attention by startups and researchers. Large-scale responses to social problems, in the form of social movements, have long made use of technologies to support and facilitate communication. However, a technological infrastructure has never, to our knowledge, been proffered by a social movement as an alternative to a social system perceived as failing. This paper explores the first case of a digital infrastructure forming the core of a social movement, in what we call the digital economic social movement of Bitcoin.

We find that digital infrastructures mediate in such a social movement, leading to a) a novel form of collective (in)action; b) new frames for meaning and legitimacy, and c) ways for digital code to translate into social action, and vice versa.

Keywords: Bitcoin, digital infrastructures, social movements, collective action, digital economic social movement

Introduction

The wake of the 2008 financial crisis has seen a number of technological solutions have become available, claiming to 'democratise' a financial system dominated by inefficient elites: from entrepreneurial finance by distributed collectives, e.g. 'crowdfunding', to entire infrastructures built and maintained through the collective action of such collectives, e.g. in the Bitcoin community. The development of these grassroots financial services is a consequence of both historically low levels of trust in existing financial infrastructures (Hilsenrath, 2010), combined with the availability of peer-to-peer digital technologies (Yoo et al., 2010). Some grassroots financial services are so vast in their ambition—and rejection of existing financial infrastructures—that they might rightly be called economic social movements first, and new services second. Indeed, they emerged at the same time as other anti-establishment economic social movements like Occupy Wall Street (Bennett & Segerberg, 2011).

It should come as no surprise that some of these economic social movements are digitally mediated (Selander & Jarvenpaa, 2016). One such social movement, developed around an open source (OS) decentralised technology, is known as the Bitcoin Blockchain (hereafter referred to as "Bitcoin"). In the white paper that first introduced this infrastructure, it was presented as an alternative to a state-led financial system—depicted as overly centralised, meddlesome and untrustworthy—and to untrustworthy and inefficient banks (Nakamoto, 2008a). While the technology has appealed to fringe groups, including libertarians, it has also given rise to a collective comprised of multiple, often competing, ideologies. While competing interests are commonplace among OS developers (Stewart & Gosain, 2006), they present complications when it comes to the development and maintenance of a core technology infrastructure. Where a technology comprises the core of a digitally-mediated social movement, these complications affect the ability of the social movement to influence the development of the core technology.

To say that the core digital infrastructure mediates the social movement is perhaps an understatement; members of the OS community ascribe values to the infrastructure, such that it becomes an enactment of the social movement. For instance, in the case of Bitcoin, the distributed nature of the infrastructure codifies the movement's democratic and decentralised character (Ingram & Morisse, 2016). Research on digital infrastructures has highlighted the generative capacity of digital

infrastructures, and the social evolution of the social movement is therefore tied up in the generative capacity of the underlying infrastructure—through its source code—in line with changing social and economic goals (Hanseth & Aanestad, 2003; Henfridsson & Bygstad, 2013). This constraining function of the source code has not been as visible in infrastructures that have previously been studied (Iannacci, 2010; Kuk & Janssen, 2013). In order to examine how collective action occurs in economic social movements, we therefore ask the following research question:

> How does collective action emerge in the digital economic social movement of Bitcoin?

We address this question through a multi-method, longitudinal case study of the emergence and evolution of the social movement organised around Bitcoin over the course of six years.

For the time being, Bitcoin is an extreme and isolated case. However, it is instructive in providing insight into the larger phenomena of organising through collective action associated with digital infrastructures (Siggelkow, 2007).

This paper is structured as follows: first, we discuss the role of digital infrastructures in economic social movements, before examining the link between the evolution of digital infrastructures and the role of collective action in such evolution. Second, we present our case study of the Bitcoin community as an example of a digital economic social movement (hereafter referred to as the "Bitcoin community"), before presenting our findings and discussing their implications for our understanding of digital infrastructures and digitally-mediated social movements.

Collective Action in a Digital Social Movement

One of the difficulties that large social movements, characterised by groups with different—and often competing—interests, is what is called a *collective action problem*. That is, a problem that requires collective action in order to overcome—but where there is no clear individual incentive to act, or even an incentive for individual members of the collective to 'free ride' (Schelling, 1978). Circumstances that give rise to collective action problems include those with high levels of uncertainty, and those where obtaining the information necessary to act has a high transaction cost (Ostrom, 1998). In very large OS communities, one could expect that high levels of uncertainty and high costs of obtaining information are commonplace (Hanseth & Lyytinen, 2010; Ljungberg, 2000). Studies of collective action, described as the

"conditions under which user coalitions would form" (Markus, Steinfield, Wigand, & Minton, 2006: 443), have focused on digital organisations (Selander & Jarvenpaa, 2016) and standards in digital contexts (Bennett & Segerberg, 2011; Markus et al., 2006).

This research shows that while shared culture and shared beliefs go a long way towards solving collective action problems (Cargill, 1989; Greenstein, 1992), more deliberate efforts are often required. Some pre-digital solutions to collective action problems include governance methods, including restricted membership (Axelrod, Mitchell, Thomas, Bennett, & Bruderer, 1995) and sponsorship by a powerful actor (Foray, 1994). Social media and the like have given rise to their own studies of "digital" collection action problems, and pointed to the positive effects of improved communication through Facebook and Twitter in solving collective action problems, for instance through direct messaging (e.g. Tufekci, 2014), or through noncommittal "likes" (e.g. Selander & Jarvenpaa, 2016).

Studies of social movements in sociology have pointed out how social movements challenge or contest existing social systems, usually mobilising in support of underprivileged or underrepresented parties (Beck, 2008; Hensmans, 2003; Kellogg, 2011). Often coming from underprivileged or underrepresented contexts themselves, proponents of change are armed with rhetorical tools rather than resources of any significance. Such tools rely on the meaning that they make out of the movement (Kurzman, 2008).

For predominantly digital social movement, the meaning given to the underlying digital infrastructure is therefore an important part of the movement (Hensmans, 2003; Kurzman, 2008) in that it frames their cause, allows them to leverage political and social opportunities, and to mobilise supporters and behave in tactical ways (Kurzman, 2008; O'Mahony & Bechky, 2008).

In the case of Bitcoin, entrepreneurs draw on ideas that are commonplace in digital entrepreneurship communities--like open source, open access and the 'distributed computing paradigm' (Garud et al., 2002; Yermack, 2013)—to frame their digital social movement, codifying its it meaning (Hargrave & van de Ven, 2006). The codification of meaning in digital technology could be said to give the social movement legitimacy by giving ascribed meanings a material form. This coherence can then act as a catalyst for solving shared problems through collective action (Hensmans, 2003).

Studies of collective action in an age of social media have shown fairly robustly that changes in technology have affected not just the way in which engagement and interaction pursuant to collective action occurs (Selander & Jarvenpaa, 2016), but that digital mediation may allow for new processes that enable collective action (Bennett & Segerberg, 2011). What these studies have in common when it comes to collective action and technology is that they show how technologies are used by,

and their effect on, social movements. However, as technologies—and their affordances—become more fundamental parts of social movements, their role in collective action as more than just tools is deserving of interrogation (Leonardi, 2010). Indeed, the most recent of economic social movements proffer digital technologies themselves as alternatives to organisations, thus showing how a technology might become the core of a social movement.

Infrastructure Change and Economic Social Movements

Social movements often offer an alternative to the institutional status quo. Implicit in challenging the institutional status quo is the suggestion that existing economic institutions have failed (Powell & Colyvas, 2008). Economic social movements are those which offer alternative economic views of the world: past research has included studies of Fair Trade movements (Wilkinson, 2007), sustainability movements (Ivarsson, 2008), and backlashes against the financial system (Bennett & Segerberg, 2011). Sometimes these social movements offer alternatives to the status quo, although not all of them do. In the case of a digital social movement like the Bitcoin one, proponents argue not just that a number of social institutions have failed, but that the technical structures—or infrastructure—that underlies existing economic institutions have failed.

Studies of infrastructures, and digital infrastructures in particular, point to the fact that infrastructures are most apparent when they fail (Star & Ruhleder, 1996). By highlighting the failures of existing economic infrastructures, and proposing new—digital—infrastructures in their place, these digital social movements aim both to change the social elements of the economic institutions which they challenge, and to do so using a digital infrastructure infused with meaning.

Such a digital infrastructure has already been outlined in extant literature: while digital infrastructures offer a technical infrastructure upon which new relationships can be built, it is the building of these relational elements on top of the infrastructure that renders it infrastructural (Star & Ruhleder, 1996; Tilson et al., 2010). Such relational elements could include explicit social framing (Star, 1999), or modules and platforms that, by virtue of their reliance on the underlying infrastructure implicitly point to its status as infrastructural (Tilson et al., 2010).

There is also an element of scale that renders a digital technology infrastructural: they are often so large, and distributed, that no single actor controls them. Instead, the sheer task of maintaining the infrastructure requires more resources and knowledge than a single person or organisation possesses, leading to a distribution of both control and decision-making structures (Yoo et al., 2010). Changes to the

underlying digital infrastructure—and thus its social framing—therefore require consensus among the collective(s) that control and maintain it.

OS communities and Collective Action in an Infrastructure

Owing to the distributed nature of those who maintain and control the infrastructure, they communicate through forums, and proposed changes to the infrastructure are materialised through the production of computer code. In the case of the Bitcoin digital economic social movement, this distributed infrastructure is controlled and maintained by an OS community. Although OS communities often form to solve a common problem (Raymond, 1999), they do not always agree on the methods that should be used to solve said problem. While they try to come to a consensus—and, in so doing, rally support from otherwise apathetic members of the collective—this is not always possible. Studies of online forums dedicated to OS projects, for instance, show that such agreements take extensive negotiation (Phang et al., 2014), and that some members of the collective are more active than others (Phang et al., 2015). When no consensus can be reached, OS developers turn to the code to demonstrate their proposed change to the underlying technology, for instance through "forking" the underlying code to create alternative visions of what the infrastructure should look like (Nyman, 2015). These "forks" are defined as when "a part of a development community (or a third party not related to the project) starts a completely independent line of development based on the source code basis of the project" (Robles & González-Barahona, 2012: 3). Such splits from the original OS project are typically discouraged, but cannot be prohibited as such projects are based on non-proprietary licences that allow the alteration and reproduction of the underlying code (Nyman & Lindman, 2013).

Code has been said to have dynamic (Aho & Hopcroft, 1974; Kitagaki & Hikita, 2007) and even agentic capabilities (Andersen et al., 2016). In the context of a digital infrastructure that supports a digital economic social movement, it is also infused with social framing that gives the social movement meaning (Hargrave & van de Ven, 2006). For instance, a decentralised system becomes democratic, reliance on cryptography makes the network independent and therefore incorruptible, and the open source nature of the phenomenon's development is depicted as making it community-driven, rather than a "top down" system.

Both social movements and OS communities face collective action problems. While social movements use narratives to rally support (Hargrave & van de Ven, 2006), OS communities make use of both narratives (through forums) and codification of these narratives (through code).

Having discussed the theoretical background to collective action in a digital economic social movement, we turn now to discussing the specific case at hand: the case of Bitcoin as an alternative financial infrastructure.

The Case: Bitcoin as a Digital Economic Social Movement

Interest in the Blockchain in recent years has largely centred on how fast it has grown in value—from around 30 (US) cents per Bitcoin in January 2011, to around 10000 USD in early December 2017. At the same time, the underlying Blockchain technology is being appropriated by banks and governments to build new infrastructures. While the second generation of Bitcoin infrastructures are often centrally controlled, the original Bitcoin Blockchain was not.

Instead, the Bitcoin Blockchain was originally built to facilitate transfers of the Bitcoin currency, and was designed to be controlled by a distributed community (Nakamoto, 2008a). In practice, it encourages distributed interaction through incentivising computers (or "miners") to solve a cryptographic puzzle—and in so doing encrypting a given transaction into a block—in exchange for which the receive a reward denominated in Bitcoin. Once a block of size 1mb is reached, the system initiates a new block, and the blocks are in a chain, as records of all past transactions, in what is known as a blockchain. Here, we will refer to the technology as the Blockchain, and the social movement around this specific digital ledger as a Bitcoin.

The original developer of Bitcoin disappeared shortly after releasing his creation. It has therefore been maintained by an OS community. However, the underlying source code puts limits on what members of the community can do. In particular, the distributed 'democratic' nature of the Blockchain means that major changes to the infrastructure must be adopted by the majority of those running the software in order to alter the underlying infrastructure itself.[21] When this occurs, those miners running the version that is in the minority are seen to be running a *de facto* alternative. That is, they are no longer running a compatible version of the infrastructure—neither the source code that they run nor the transactions entered into minority-held alternative blockchain will be recognised by the majority-held infrastructure. This code implementation prevents individual actors from changing the blockchain itself.

[21] Whether majority is a simple majority of 33% or an absolute majority of 50% is under debate, see e.g. Eyal, I. and Sirer, E.G., 2014, March. Majority is not enough: Bitcoin mining is vulnerable. In *International Conference on Financial Cryptography and Data Security* (pp. 436-454). Springer Berlin Heidelberg.

However, minor changes to the code that do not affect its core function can be implemented by individuals without larger consensus or adoption.

A Developmental Impasse

Our interest in this case came about when the OS community experienced a failure of the infrastructure: it had been designed to accommodate a relatively small number of transactions. As Bitcoin's use grew, so too did the number of transactions being processed, such that the distributed nature of the infrastructure made it less efficient than the existing financial system, not more.

Multiple proposals emerged for how to remedy this slowness, which was seen to undermine the future of the Blockchain as an economic social movement (Hearn, 2015).

One proposed solution was to increase the size of each block, from 1mb to 4mb. Increasing the block size would reduce the number of miners able to run the software (owing to issues around processing power), but would increase the Blockchain's transaction handling capacity. This new version is known as BitcoinXT, and it would essentially make control of the infrastructure more centralised, but allow it to handle more transactions fairly cheaply.

Opponents to this change label the original version of the Blockchain Bitcoin Core, and they argue that, among other things, XT is untried and may not scale well (with which XT proponents disagree). They also argue that this change would make the project more centralised, putting more power in the hands of fewer miners—who could make more drastic changes in the future. In essence, they agree with the need to do something, but argue that the shift to XT sets a dangerous precedent.

Those who backed the Core version of the code preferred a system in which distributed control was maintained, and where those wanting to make transactions could pay miners for a faster transaction time.

The XT and Core versions of the Blockchain are fundamentally incompatible; this means that participants in the network, whether miners or entrepreneurs running platforms on the Blockchain infrastructure, have to choose which version to run. Ultimately, the version that garners the most support will become the "real" Blockchain.

What makes this shift an institutional one rather than just a change in code is the fact that a shift from Core to XT will mean that more than just code will change. The explicit change in rules around how transfers are handled codifies a change in the social movement that was defined by its distributed nature. Beyond the different block size, the norms around the community are therefore altered. As

members of the Core point out, the shift will centralise the infrastructure more, putting more control in the hands of fewer. Moreover, the larger block size is intended to facilitate wider use of the Blockchain; this mainstream appeal is likely to dilute further the group of enthusiasts for which Bitcoin has become known.

However, this extreme case—where proponents of changes have to persuade others to implement them at scale (collective action) was not the only action we saw in the community forums as we analysed them. We therefore expanded our investigation to look at patterns of action, including collective action, in this digital economic social movement. In so doing, we hoped to distinguish action, collective action, and inaction.

Data Collection and Analysis

The goal of our analysis was to explicate how collective action is instantiated and actualised in the interplay between digital infrastructure and social movements. In order to reach this objective, we conducted a six-year longitudinal qualitative analysis of digital trace records of interactions among members of the Bitcoin community. Data collection and analysis was conducted in three steps, summarised in Table 16.

Table 16: Overview of Analysis and Methods

Analytical Step	**Analytical Technique**	**Analytical Outcome**
Initial coding for instantiations of potential collective action	Topic modelling using Latent Derilecht Allocation (LDA)	Identification of 45 events of potential instantiation of collective action
Axial coding for distinct paths of collective action instantiations across the case history	Manual coding of topic clusters resulting from the topic model	Explication of six paths of collective action instantiations throughout the case history
Theoretical coding for patterns of collective action	Theoretical coding of the data to discern specific patterns of collective action organising	Explanation of the emergence of collective action and its impact on the social movement

Initial coding of observed interactions to identify instantiations of collective action in the Bitcoin community. The second step identified paths of instantiation events over time to assert whether instantiations were actualised, and finally the third step

was tailored to explicate how patterns of collective action instantiations over time potentially resulted in collective action with a given effect on the social movement.

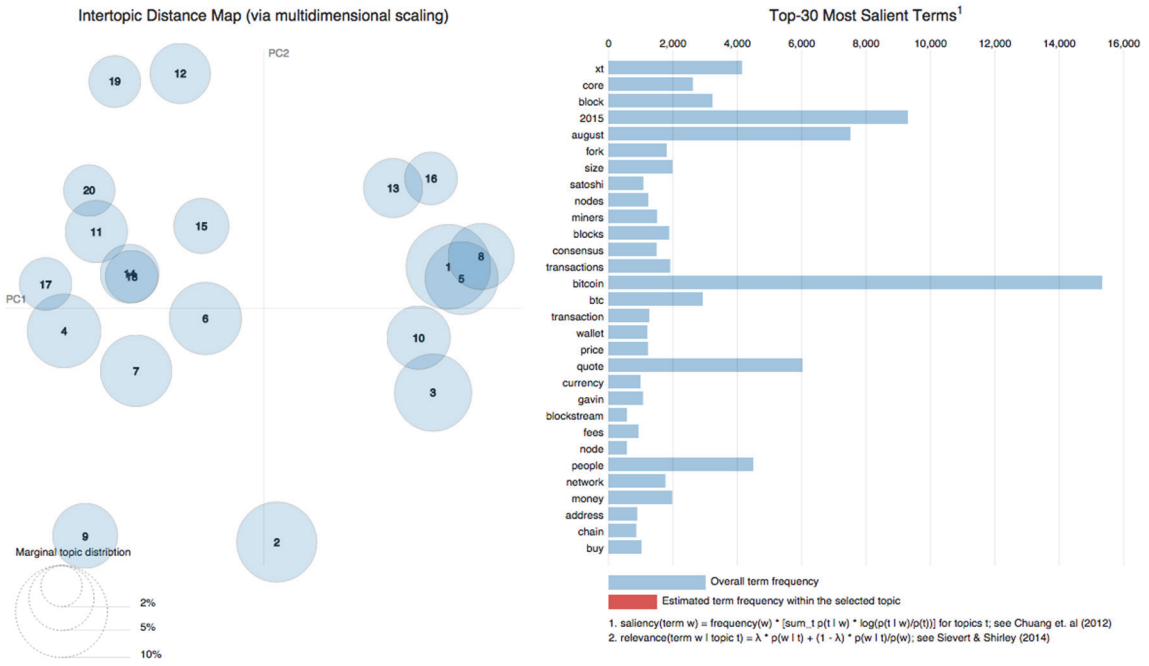
In the first step we used computational content analysis to code digital trace records (Hedman et al., 2013; Howison et al., 2011) for observable instantiations of collective action in the Bitcoin community.

We collected 13 032 conversation threads from the online forum bitcointalk.org each representing a micro-interaction in the case history. The digital trace data covers a period from October 2010 to September 2015. Bitcointalk.org is a forum dedicated to discussions around Bitcoin, primarily in English. It is among the most prominent forums used by Bitcoin enthusiasts. However, unlike mainstream forums like Reddit.com, it is often used specifically by Bitcoin professionals meaning that interactions on Bitcointalk.org are particularly linked to the development of the Bitcoin community and the underlying Blockchain. Furthermore, it contains sections that are both general and specific in nature; for instance, threads around the technicalities of the Blockchain and mining as well as discussions of the ideological underpinnings of the community.

We approached the digital trace data using longitudinal topic modelling to generate our open coding (Glaser & Strauss, 1999). We began analysing this data by conducting a first level coding using the computational natural language processing (NLP) technique Latent Dirichlet allocation (LDA) implemented in the open source statistical software R. LDA is a supervised, generative topic model that reveals patterns in a set of documents by extracting unobserved groupings (latent themes) based on semantic similarities between different parts of the data (Sievert & Shirley, 2014). LDA discovers latent themes within a collection of documents (interactions) by sampling a topic for each word at every iteration of the algorithm and ranking words based on their 'relevance' to each topic, which therefore has a unique distribution over words that can be compared using similarity measures (Chuang et al., 2012). An illustration of the patterns resulting from this first is shown in Figure 11.

The figure contains a summary of the digital trace data, where each topic bubble on the left represents a distinct topic. The histogram to the right contains a list of the 30 most salient terms for each topic, in this case topic 8. The left-hand bubble diagram clusters topics according to how they relate to one another in terms of semantic similarity measures – with overlap indicating concurrent discussions or the use of overlapping terminology. This initial coding was employed as first level, or open codes (Glaser, 1992; Urquhart, 2012) by fitting an LDA topic model over the large set of 13 032 documents in the digital trace data.

Figure 11: Visualisation of the LDA analysis for the 5-year case history

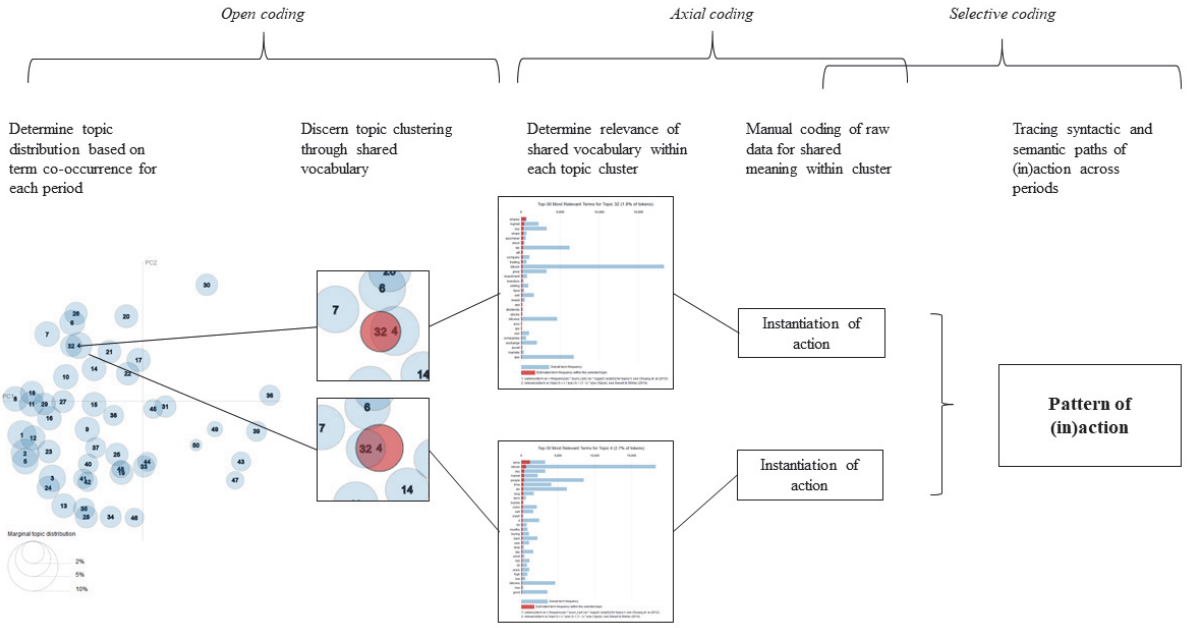


The collected digital trace data was then divided up into four phases: October 2010-December 2011 (71 threads), January-December 2012 (131 threads), January 2014-July 2015 (2 732 threads), and August-September 2015 (9 736 threads). Each period was analysed separately using LDA to generate open codes for each time interval.

We then built upon these initial longitudinal codes by generating a set of axial codes for each period (Glaser & Strauss, 1999) that allowed us to connect instantiation events across time periods based on semantic overlap and thematic grouping. Axial codes were identified in the data by coding for an overlap in relevant terminology between two or more topics. Looking at clusters of these terms by topic allowed us to discern combinations of topics under discussion by users, as well as how these topics overlapped with one another, thus identifying connections between instantiation events. This period-by period clustering was then used to generate a longitudinal description of the different paths of potential collective action instantiation (See Figure 12). We coded the textual content of the interactions until we were satisfied that the description of each path had been saturated.

Finally, we compared the emergent paths theoretically coding for the relation between the emergence of specific paths and the occurrence of collective action with an impact on the social movement. This enabled us to determine the interaction between digital infrastructure, collective action and its impact on the social movement over time.

Figure 12: Illustration of analytical techniques



Next, we move on to apply this analytical framework to an analysis of collective action and digital infrastructure evolution in the Bitcoin community.

Collective Action in Digital Economy Social Movements: The Case of Bitcoin

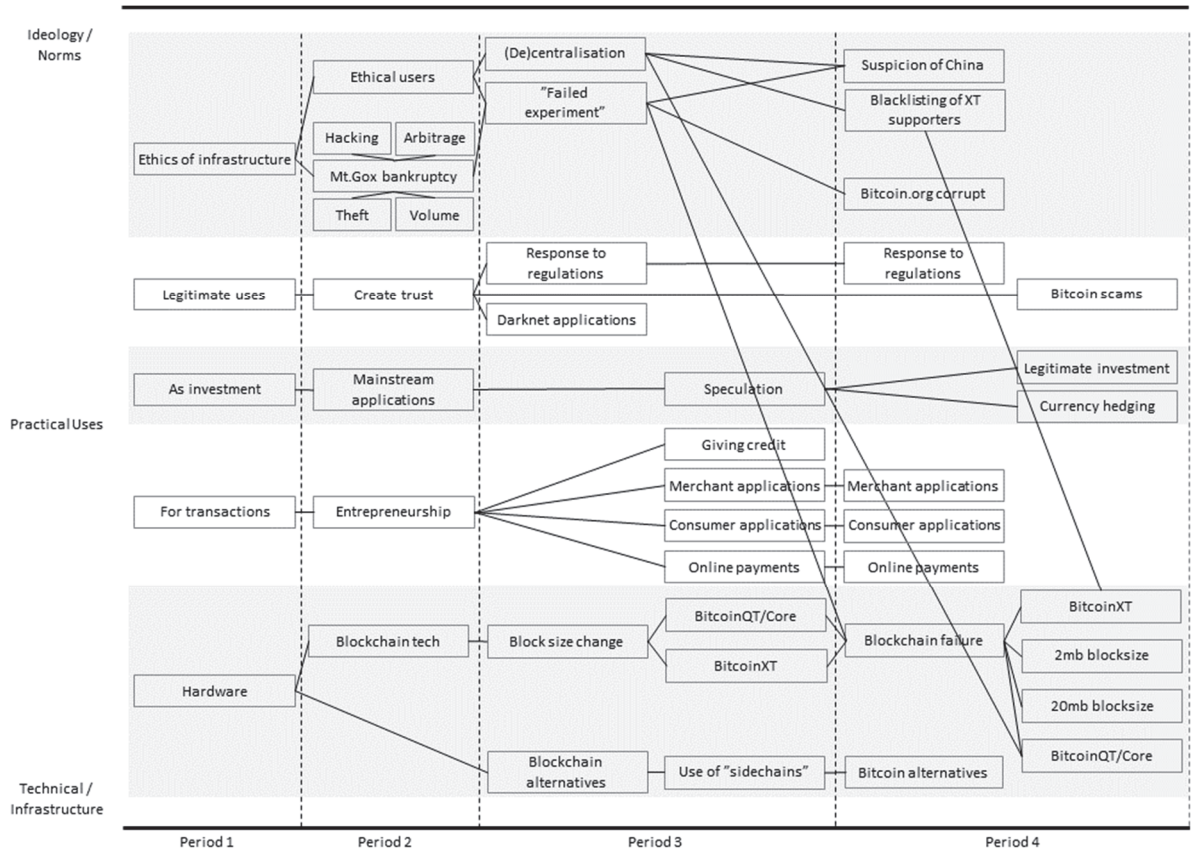
Our analysis shows how the Bitcoin community evolved along four distinct periods. In Period 1 (October 2010 - December 2011), forum discussions centred on creating and operating a working digital currency with one divergent issue relating to the Harakuryu Ponzi scheme. Period 2, January-December 2012 saw discussions centre on the collapse of a prominent Bitcoin retailer called Mt Gox, with some interest in processing transactions and the emergence of Bitcoin as a currency, as well as an emerging discussion around changing the underlying protocol. Period 3, January 2014 - July 2015 focussed on the importance of Bitcoin as a currency, including its legal status, but potential protocol changes and ideological differences also elicited considerable attention. Period 4, August-September 2015, saw two primary discussions in the forum data: the importance of Bitcoin as a currency, and the importance of the need for institutional change in the Bitcoin community, specifically around the Blockchain block size.

Using the methods illustrated in Figure 12, we identified distinct events relating to the instantiation of collective action in the case history. Our starting point was

to treat the forum data as representing interests of those using/maintaining Bitcoin and underlying infrastructure. While there was considerable "noise" in coding the data resulting from the initial computational analysis, we also reached a point of saturation, in which codes began to repeat themselves (Bowen, 2008). Manually mapping out these topical shifts on a period-by-period basis not only helped to make sense of the divides between the various topics, it also showed how the themes addressed created paths over time. For instance, it showed how initial discussions around the underlying Blockchain hardware and software evolved in time to become discussions around their versatility, including whether they could be adapted for use with different kinds of hardware.

As the data in the forums showed participants' orientations and understandings of the most important (or most interesting) issues around Bitcoin at the time of writing, we were able to track the twenty most important topics to the community in a given period, and across the four periods described. Clustering these codes and then arranging them on an axis from ideological to practical, to technical and connecting these themes across time to form thematic 'paths' generated Figure 13. As the figure shows, a number of separate paths of events relating to instantiations of collective action emerged and dissolved over the course of the trajectory. Notably, each path typically seems to emerge and gain momentum at a specific point on the ideology/technology spectrum before either dissolving or crossing over to impact paths at a different level. Specifically, period 4 representing the forking of the Bitcoin code base into Core and XT versions includes such path transitions where ideological paths impact the technical infrastructure and technical paths generate new institutional and ideological norms. To a certain extent this is not entirely surprising in that we know already the history of Bitcoin. What this analysis provides is an instrument to derive the underlying patterns of collective action.

Figure 13: Paths of potential collective action instantiation



Collective Action in the Bitcoin Community

Our historical analysis of emergent topics over time allowed us to identify a number of potential areas for collective action in response to problems (or potential problems) that the community faced. Figure 3 shows these potential areas for collective action, resulting from the coding process described in the previous section. These ranged from dealing with the social meaning attributed to the underlying infrastructure (at the top of the vertical axis), to the technical elements of the infrastructure, as contained in its infrastructural architecture (at the bottom of the axis). While dealing with the different challenges associated with the future of the community and the infrastructure presented possibilities that were distinctly social, practical or infrastructural, there were occasions where these paths cross-pollinated.

This longitudinal mapping that resulted in (in)action, in the face of community-wide challenges, showed not only what led to the forming of action over time, but what form the ultimate instantiation took.

Instantiations of Action

First, there were those that were fairly clear-cut, for instance the technical discussion around alternative uses of the Blockchain. Others were clusters that had little longitudinal significance, for instance the bankruptcy of the firm Mt.Gox, which was largely self-contained. The vast majority of actions leading to possible collective action, however, diverged and converged in multiple places. For instance, the paths around the need to change Bitcoin to keep up with transaction volumes split into four discrete possible paths. Lastly, the technical and ideological streams of themes tended to cross-pollinate one another, while practical (largely entrepreneurial) uses cross-pollinated internally. Grouping these themes together, we identified six patterns of action in the Bitcoin community (see Table 17).

Table 17: Instantiations of potential collective action in the Bitcoin community, their impact, and illustrations

Instantiations of potential collective action	Characteristics of instantiations	Examples of instantiation events	Example quotations	Impact on social movement
Community Consensus	Persistent over two or more periods without diverging	Response to regulations	"Well, you are assuming here that storage space/bandwidth will increase at the same rate as the number of transactions. I guess there is an equilibrium point somewhere here. Bitcoin just have to wait until better tech comes around. So technically, if there is no better tech, Bitcoins fucked." (September 14, 2012, 06:33:54 PM)	Streamlined application of code, in line with social and practical considerations
		Failed Experiment		
		Bitcoin alternatives		
Collective Inaction	Action terminates after one period	Chinese dominance	"No such thing as "Free". These sites make money off of you via advertising and your time. In my personal opinion it seems like most of these sites are set up in order to make the operators money. While giving the users fractions of pennies in order to have them slave for the site developer." (September 19, 2013, 08:38:57 PM)	Failure of community to agree on social or technical response to perceived threat(s)
		Bitcoin Scams		
		Bitcoin.org corrupt		
		Giving credit		
Response to crisis	Self-contained hub of activities	Mt.Gox bankruptcy	"It's possible that MtGox is delaying the BTC withdrawals in an attempt to buy time to identify those responsible and recover some of their scammed coins. But the harm MtGox did to themselves and to the market by acting so is IMO much greater than the theft itself (which was facilitated by their negligence)." (February 21, 2014, 04:24:40 PM)	Short-term response prompted by external events
Entrepreneurial diversification	Divergent paths from a single action in the previous period	Merchant applications	"At the moment the number of people using bitcoin regularly is probably a "small town's worth. A few tens of thousands. This makes selling a niche product or service difficult…If you take the slightly longer term view and think "hmmm, bitcoin could easily be used by millions of people" then you will be eventually selling your service (which by then has a fantastic website, is thoroughly debugged and dispatches/ expedites super efficiently) to a whole metropolis. Think selling to the whole of New York's population.	Innovation of technology, making use of code, as a result of 'market' pressure or community concerns
		Consumer applications		
		Online Payments		
		Investment		
		Currency hedging		

Instantiations of potential collective action	Characteristics of instantiations	Examples of instantiation events	Example quotations	Impact on social movement
			Other people will then try and copy you, but you have the first mover advantage and your service just works." (May 22, 2012, 09:42:20 AM)	
Ideology encoding	Activity with both social and technical antecedents in the previous period	Blockchain failure	"The core principle of Bitcoin ideology is the decentralization of currency, and for what pupose? We all know the answer to this question. It is because we all know the evil that men drunk with power will do to his very own blood let alone what he would do to you. But what do you think it means if crypto-coin mining becomes just another resource that only rich corporations can afford to harvest?... If crypto-mining is only available to an elite group of wealthy individuals, then it becomes subject to the concerns of the elite." (June 07, 2013, 01:32:07 PM)	Encoding of ideological norms and values in digital infrastructure through collective action
		Bitcoin Core		
Sub-optimality correction	Technical activity linked to social activity in same period	BitcoinXT (incl. diverging)	"Warning: "Bitcoin" XT, Classic, Unlimited and the likes are scams. Don't use them, and don't listen to their shills." (May 06, 2013, 05:20:40 AM)	Technical implementation of code that leads to social backlash

s

The final step in our analysis involved comparing our coding of the different paths to determine the underlying mechanisms by which they are generated. We did this by comparing our coding of the different paths focusing especially on the relations between each path. By grouping these relations into broader categories, we identified six separate patterns relating to the generation of institutional and technological change in the Bitcoin trajectory. Each pattern, as illustrated in table 2, is thus linked to the generation of a specific set of related paths and specific outcomes in the form of socio-technical changes to either digital code or institutional entities.

Instantiations of Collectives-In-Action

Although this paper is about collective action, it is not always the case that a community disagrees about how to proceed in a certain area, nor are there always incentives to 'free ride', nor is a critical mass always needed for action to occur.

Community Consensus

In analysing the activities discussed in the data, we identified a number of instances in which the community either came to a consensus, or did not require a critical mass to proceed. This pattern is referred to as community consensus. These instances of action are contained in the first row of Table 2, and include the acknowledgement that the Blockchain was a "failed (social) experiment", unable to scale to meet rising demand:

> "By default Bitcoin will not created blocks larger than 250kb even though it could do so without a hard fork. We have now reached this limit. Transactions are stacking up in the memory pool and not getting cleared fast enough.
>
> What this means is, you need to take a decision and do one of these things:
>
> Start your node with the -blockmaxsize flag set to something higher than 250kb, for example -blockmaxsize=1023000. This will mean you create larger blocks that confirm more transactions. You can also adjust the size of the area in your blocks that is reserved for free transactions with the -blockprioritysize flag.
>
> Change your nodes code to de-prioritize or ignore transactions you don't care about, for example, Luke-Jr excludes SatoshiDice transactions which makes way for other users.
>
> Do nothing.

> If everyone does nothing, then people will start having to attach higher and higher fees to get into blocks until Bitcoin fees end up being uncompetitive with competing services like PayPal." (March 06, 2013, 09:44:20 AM)

As this quote illustrates, while there was consensus on the fact that the Blockchain was facing a technical failure, there was no social consensus on how to proceed. Instead, there were competing solutions proposed—visible in the attempts at Collective Action described below.

Other areas in which the community came to consensus was in the idea that they needed to respond to regulations, as well as in the interest in—and importance of—alternatives to Bitcoin.

Collective Inaction

Implicit in the idea of collective action is the fact that collective action does not always occur. Instead, despite acknowledgement of the fact that something needs to be done, no-one has any incentive to do it themselves, whether because the scale of the task is too large for one individual, there are no rewards for that individual, or because there is an incentive to free ride. The result is a pattern of *collective inaction*.

Cases of this in this data include responding to external threats to the Bitcoin infrastructure and community, as described in Table 2. The most vivid of these is the dominance of China in Bitcoin, both because they controlled the bulk of the mining capacity, and because Chinese activities strongly influenced the Bitcoin price:

> Currently BTC is on a downhill slope with the recent news of China's new regulation on banning third party payments on all exchange platforms. Without the co-operation of China's policies towards BTC it has exacerbated the value of BTC. Why has it hindered the value of BTC so much? When there has been some goods news of BTC in India, Korea, Denmark and BTC start-up companies. It looks grim for BTC without China in the picture and you might say we don't need China other countries will acknowledge it and there will be mass adoption but look at the value of BTC now without China in the picture. China obviously is a big player and I can't see BTC hitting a new milestone or even hitting the peak of $1,300 BTC but I hope I am wrong. What do you think? (December 18, 2013, 10:54:17 AM)

Other failures to generate collective action include responses to Bitcoin scams, the interest in developing a technical solution that would allow the Bitcoin protocol to issue credit.

This collective inaction might also be called collective action failure, depending on the antecedents of the action. However, it can also be the case that inaction oc-

curs because that is what is in the best interests of the community. As such, rather than a collective action failure, such inaction would constitute an active decision on the part of the community. In the case of the Chinese dominance described above, it is likely that the Chinese control so much of the community, that although other members of the community have an incentive to respond to their dominance, the fact of their dominance precludes this possibility.

A more concrete example of collective inaction lies in the case of giving credit. While the possibility has not been entirely abandoned, it has been argued that giving credit in a system (like Bitcoin) in which there are central bank guarantees is potentially dangerous:

> If there's no backstop such as the one which central banks provided in 2008, you could potentially see a rapid contraction of credit down to zero and complete collapse of the entire system as everyone tries to exchange their credit for something tangible. (December 28, 2012, 02:34:03 PM)

Crisis Response

The community occasionally also faced the need for crisis response. The most notable during our period of study was the bankruptcy of a Japan-based Bitcoin exchange called Mt.Gox in 2013. This bankruptcy—and how to respond to it—rallied Bitcoin enthusiasts from across the globe, largely because everyone was affected either directly or indirectly. Those who were directly affected lost money through the bankruptcy, while those indirectly affected were hit hard by the criticism that the technology came under as a result of the bankruptcy, seen to have been the result of a flaw in the blockchain code:

> …looks like green adresses are failing , theese things are non confirmation adresses , witch should be protected by MTGOX.... because the bitcoin network did not confrm yet , BITSTAMP does not seem to have this problem , NOR does BTC china!so it is NOT a general bitcoin problem.but a gox green adress problem.so THIS IS A GOX ONLY PROBLEM! , not bitcoin! if it was a general btc error Bitstamp would have had the same problem and so would have BTC china! (February 10, 2014, 10:50:20 AM)

While responding to a crisis is relatively self-contained and does not affect much of the rest of the development of the community. In contrast, collective action is so tricky in the context of the Bitcoin community precisely because the implications of (in)action are so vast.

Entrepreneurial Diversification

Finally, entrepreneurial diversification refers to code-based activities wherein new modules, in the form of entrepreneurial firms, are developed in response to external pressures. This mechanism can work in two ways: either in the sense of importing institutional pressures in the form of e.g. consumer demand or ideology, which is then implemented in the digital infrastructure, or by applying the underlying code of the digital infrastructure in different contexts, thus exporting digital code.

> Software development team here. We would like to hear from the community what are the most annoying\frustrating stuff you have with Bitcoin and would love to get a solution for ?Feel free to talk about any problem, even if it seems unsolvable or too abstract (e.g. Bitcoin is not safe enough for the average user) Edit:After reading all the replies, I feel confident summarizing that the #1 problem of Bitcoin is probably lack of adoption. And the main reasons of lack of adoption are probably ease of use and insufficient security. We are a team of entrepreneurs and software developers that are going to spend the next following months-year on developing a new product.One of the most appealing markets for us is the Bitcoin market.We will try to learn us much as possible from your replies and try to tackle the problems head on. (June 27, 2015, 03:19:37 AM)

Instantiations of Collective Action

The data revealed significant patterns of action that meet the requirements for collective action, i.e. patterns of action revolving around a problem that required collective action from community at large, despite there being difficulties in coordinating and incentivising individual members to act.

Ideology encoding

Ideology encoding refers to a concrete instance in which ideological values and beliefs are, using digital code, encoded into the infrastructure. The collective action that results relies on ideology to coordinate and incentivise individual actors to carry out certain activities. In this case, this encoding led collective action by a critical mass of members to, while acknowledging the failures of Bitcoin, opt to retain the Bitcoin Core version of the infrastructure:

> Bitcoin is a decentralized system, in which if you run a full node YOU HAVE A SAY in what rules are to be followed. … The ONLY way for rules to ever change for you is if YOU PERSONALLY download a new client version with new rules. I cannot stress enough how important this is. This so important that it should be paramount for anyone who has any significant wealth in Bitcoin to run your own full node regardless of the costs that brings to you. … But if you want to keep the Bitcoin money system run-

> ning under the principles that it is built upon today (FINITENESS, TANGIBILITY, TRANSPARENCY, ANONYMITY, SECURITY, DECENTRALIZATION, SELF-OWNERSHIP, INTEGRITY, PRACTICALITY, RATIONALISM) it is paramount that any such rule changes do not immediately or down road preclude you from being able to run a full node. Because if you can't run a full node and you trust someone else to do it for you, then you have effectively given away your power to have say about what rules Bitcoin follows. Right now you are a sovereign in Bitcoin. You should never give that up, under any circumstance. What do I mean with sovereign? Well there's nothing anyone could possibly do that can make you accept rules you didn't agree with. Nothing. You yourself have to decide to consent to a rule change. But if running a full node becomes impossible for you then all that which you were told about Bitcoin, that rules virtually can't change, that it has a strict limit of 21million, ect, all these rules will then be left to be decided by a small number of super nodes and the people who control them. The second this becomes reality Bitcoin will be no different than simply a slightly more transparent Paypal. And if you don't want that you better make damn sure you can run a full node. (March 07, 2016, 01:54:06 AM)

As illustrated in the quote, the 1MB block size and distributed structure of the Bitcoin Core codebase represents a set of ideological beliefs, values and norms about an alternative financial and economic structure. Thus, these beliefs coordinate individual actions, leading to collective action despite the scale of the problem—and the lack of other clear incentives for action.

Sub-Optimality Correction

A *sub-optimality correction* refers to the generation of collective change to the social movement through technological adaptations to the digital code. The corrections may occur in response to a tangible short-term problem, but have long-term impact on the code, and thus the fabric of the social movement.

Given that community ideologies prefer a less centralised version of the underlying infrastructure, it might make sense for community members to remove threats to alternative code developments. In order for such "threat removal" to be effective, it needs to be credible and effective—which requires coordination and response at scale:

> Sometimes bottleneck happening,too much-unconfirmed transaction when the blocksize only limited for 1mb,and it'll affect on your transaction,need to wait longer than usual and sometimes it'd took time about 1 hour or more,it's sure a problem i guess, i'm sure you don't want to wait about ~1hour when your client is waiting for the transaction. I can catch up your point dude, you are absolutely right that sometimes the transaction of bitcoin have been delaying even troubled. But i hoe that problem will fix by developers of bitcoin. (May 27, 2016, 11:15:24 AM)

It has been speculated that the 1MB block size mentioned in the above quote would present a significant constraint to the scalability of transaction volume possible on the infrastructure. In turn, the technological fix of increasing block size means that more computing power is needed to participate in the network effectively instituting a division between standard users and an additional layer of 'trusted third parties' capable of maintaining the transaction ledger. In this case, the threat removal, seen as a sub-optimality in the code, was eliminated using a boycott of all those making use of the XT code.

Having established the emerging trajectories and patterns of action in the Bitcoin community, we now discuss these findings in the context of existing literature on collective action and digital infrastructures, and suggest venues for further research.

Discussion

This paper builds on our understanding of the role of digital infrastructures in social undertakings, and social movements in particular. Through a longitudinal examination of the Bitcoin community, we a) propose a new class of infrastructure-based social movement, namely the digital economic social movement; and b) show how collective action is instantiated and actualised in the digital economic social movement of Bitcoin. Our findings highlight the role the infrastructure plays in mediating action by the members of the social movement: leading to inaction, consensus, and collective action. These developments raise a number of questions in relation to existing literature on digital infrastructures and collective action.

A Digital Economic Social Movement

The generative capacity of digital infrastructures has been highlighted consistently in previous research. However, it is this *generativity* that is consistently emphasised (e.g. Hanseth & Aanestad, 2003; Henfridsson & Bygstad, 2013), rather than the contextualisation of the digital infrastructure within a social context with its own set of social and, in this case, economic goals (Star, 1999). The conceptualisation of a digital economic social movement combines our understandings of digital infrastructures as code-based, generative foundations for activity (Henfridsson & Bygstad, 2013; Star & Ruhleder, 1996) with the social movements' attempts to challenge or change a problematic set of social conventions (Kurzman, 2008; Lounsbury, Ventresca, & Hirsch, 2003; Tufekci, 2014). Indeed, it highlights how the widespread belief that technology can solve both large and small social problems (e.g. Libert et al., 2017; Toyama, 2015) is incomplete.

Moreover, this new class of social infrastructure is code-based in nature, and many of those who are part of the social movement are also part of the underlying OS community. Thus, while social agendas can be persuasive through existing methods (like legitimacy, framing, and others), the possibility of social change through code-level changes to an infrastructure is not only a possibility, it is a reality. In the case above, many of the potential responses to challenges that the social movement faced were translated into additions to, or changes to, the underlying code base.

Collective Action in Such a Movement

We find that these code changes and additions provided a concrete frame upon which meaning could be framed. As such, they reduced uncertainty and provides a rallying point for collective action, as well as reduced the costs of obtaining information. Codification of potential solutions to collective action problems—or interactions between the ideologies and technology at the level of infrastructure—facilitated instantiations of action.

In the case of code changes that led to collective action, we found that not only was a social critical mass necessary, but that mass adoption of this code led to collective action through both ideology encoding and sub-optimality correction. We further find that the structure of the infrastructure (contained in code) enables and constrains what other actions can be taken, given that the infrastructure is imbued with a social meaning that gives the social movement legitimacy.

Thus, as in the case of Bitcoin, a digital infrastructure may be proffered as an alternative to an existing set of social institutions, themselves having been rendered infrastructural by virtue of their use. In our examination, we offer a more contained view of the digital infrastructure: as something that mediates the evolution of a social movement, while it in turn is affected by the actions of those involved in the social movement. We therefore examine the interplay between the digital infrastructure and the collective that develop and maintain it—and who do so as part of a social movement.

Actualisation of Collective Action through Translations between the Social Movement and the Digital

As illustrated in our findings and shown in figure 3 and table 2 above, the actualisation of collective action in the context of digital economic social movements rests on the translation of ideology into technological development or the translation of new technological development into ideological tenants (see the crossing paths in figure 3). Without these technological mediators, any number of actions by an OS

community pursuant to a social movement would be possible: the limitations would only be social in nature, for instance, the need to organise (Selander & Jarvenpaa, 2016), or the need to find incentives to encourage action (Ostrom, 1998). Conversely, digital mediation introduces a new way for collective action to be actualised, namely through ideology-technology translation.

While the exact threshold is unclear, what is clear is that the actualisation of ideology through technology translation, or as translation of technological changes into ideology, is needed. In other words, for an ideological development within the community to manifest as collective action, its supporters needs to *both* mobilise a significant number of community members to translate it into digital code *and* then have them adopt the resulting new technology. This process is contingent on generating the necessary momentum to pass some threshold of mobilisation within the digital economic social movement. For instance, in the disagreement over collective action around the Bitcoin Core and XT forks, the actual code became not only a rallying point for those who preferred one side over another, it also showed what the choice would look like, insofar as the infrastructure encodes certain narratives around the nature of the social movement.

Likewise, technological changes need to be significant and salient to a big enough part of the community to mobilise the negotiation of new ideological development. For this to succeed, the encoding of a narrative within the social movement onto the infrastructure, for example the 1MB block size into the Bitcoin Core discussed previously, required in mobilisation. This combination of social and technical mobilisation allowed for corrections in the community in response to technical shortcomings related to transaction capacity and speed within the Bitcoin infrastructure.

Collective inaction is harder to see in the data: although both social and technical mobilisation have occurred, the collective decision is a decision to do nothing. It therefore closely resembles instances in which neither social nor technical mobilisation has occurred. For example, new applications of Bitcoin in giving credit raises a number of both technological and ideological challenges to the social movement, which requires mobilisation on both fronts.

While collective (in)action may not occur in the absence of both social and technical mobilisation, other interactions might. These include entrepreneurial diversification, or additions to the social movement that do not require the consent of the collective—in this case, through entrepreneurial ventures in the form of code-level additions to the infrastructure (Yoo et al., 2010). Responses to short-term crises also can occur without the full range of mobilisation; either narratives (social mobilisation) or individual-level technical protections (technical mobilisation) amount to actions in this context.

In conclusion, digital infrastructure development is a medium for the enactment of collective action through reducing uncertainty, costs of coordination, and the costs of obtaining the information needed to actualise collective action.

Implications for Digital Economic Social Movements

Previous studies of Economic Social Movements have studied economic processes that are perceived to have failed, and often offer alternatives to the status quo (e.g. Bennett & Segerberg, 2011). However, social movements in a digital age, whether economic or otherwise, are increasingly relying on technology to solve social problems. In the case of Bitcoin, the belief is that the Bitcoin infrastructure is robust—and expansive—enough to provide a blueprint for how to replace the entire financial system.

Extant research into collectives building consensus, with and without collective action problems, has shown that it is possible for individuals in multiple dispersed social and geographical contexts, with specific and diverse agendas and characteristics, to interact to build consensus (Boudreau & Lakhani, 2009; Lakhani & Panetta, 2007). However, coming to a consensus in these situations is hard: while there may not always be a dearth of incentives, as in traditional collective action problems, the size and scope of OS communities means that obtaining information and rallying around a particular pattern of action presents its own kind of collective action problem. While some solutions to these problems exist, for instance the use of collective action repertoires (Selander & Jarvenpaa, 2016), sponsorship (Foray, 1994), and restricted membership (Axelrod et al., 1995), these solutions do not engage with the digital materiality of an OS project. Such materiality is particularly apparent when an economic social movement, in the form of a digital infrastructure, is at issue. In such a case, the use of code in enabling—and constraining—action in a social movement is instructive.

Digital infrastructures reduce the costs of coordination by providing a means to enact the choice. That is to say, they provide a pre-prepared range of possible change to the infrastructure that mobilised different parties within the community to make changes to the infrastructure without central coordination from those involved. Additionally, digital infrastructures reduce uncertainty by providing a tangible medium for the representation of collective action

Implications for Digital Infrastructures

Although studies of digital infrastructures are gaining interest and traction, they are typically within new fields where the infrastructures are run by established organi-

sations (e.g. Eaton et al., 2015), and where they do not directly challenge incumbent infrastructures (Yoo et al., 2010). While it is understood that digital infrastructures are typically controlled by distributed teams or individuals (Hanseth & Bygstad, 2015; Henfridsson & Bygstad, 2013), it has not been suggested that these collectives have larger social or technical aims in mind.

This paper opens up the vista, both empirically and theoretically, for studies of digital infrastructures with macro-level social aims, as is the case with a digital economic social movement like Bitcoin. Not only does such an infrastructure directly challenge incumbent infrastructures in a field, but the absence of a clear organisation behind the infrastructure means that new methods of control, guidance, mobilisation and coordination are required. As mentioned previously, while the belief that technology can solve social problems is widespread, this view is incomplete. The introduction of a new technology at the level of infrastructure brings with it new troves of problems—both social and technical in nature.

Conclusion and Directions for Future Research

In this paper, we investigated how collective action emerged in the digital economic social movement of Bitcoin. In so doing, we contributed to understanding social movements in a digital age, and digital infrastructures importance in distributed social settings. In particular, we showed a) how collective action occurs when social and technical mobilisation occurs in a digital economic social movement. This typically occurs through b) translation of social needs into technical requirements, or technical characteristics into social frames. Such mobilisation might also result in c) inaction; or just ordinary actions that build upon the social movement or underlying infrastructure. In engaging with the interactions between digital infrastructures and social movements, we also offered an understanding of the idea of a digital economic social movement, with implications for both studies of social movement and our understandings of digital infrastructures.

These contributions opened up a number of areas for future research. These include: First, the new social and technical problems introduced when an infrastructure is a core part of a social movement. Second, as infrastructures are composed of code, questions around the agency of the code—and encoding of human errors—remain. Lastly, the case of Bitcoin examined an only partly automated movement, with significant interaction between the social and technical; what if a social movement were reduced almost entirely to an automated technical infrastructure—what would it look like, and how would it act?

References

Aanestad, M., & Jensen, T. B. 2011. Building nation-wide information infrastructures in healthcare through modular implementation strategies. ***Journal of Strategic Information Systems***, 20(2): 161–176.

Abrams, R., Goldstein, M., & Tabuchi, H. 2014, February 28. Erosion of Faith Was Death Knell for Mt. Gox - The New York Times. ***New York Times***. http://dealbook.nytimes.com/2014/02/28/mt-gox-files-for-bankruptcy/, January 30, 2016. [Accessed November 22, 2014]

Agrawal, A., Catalini, C., & Goldfarb, A. 2015. Crowdfunding: Geography, social networks, and the timing of investment decisions. ***Journal of Economics & Management Strategy***, 24(2): 253–274.

Ahlstrom, D., & Bruton, G. D. 2001. Learning from successful local private firms in China: Establishing legitimacy. ***The Academy of Management Executive***, 15(4): 72–83.

Aho, A. V, & Hopcroft, J. E. 1974. ***Design & Analysis of Computer Algorithms***. Pearson Education India.

Al-Atabi, M., & DeBoer, J. 2014. Teaching entrepreneurship using massive open online course (MOOC). ***Technovation***, 34(4): 261–264.

Alavi, M., & Leidner, D. E. 2001. Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. ***MIS Quarterly***, 107–136.

Aldrich, H. E. 2012. The emergence of entrepreneurship as an academic field: A personal essay on institutional entrepreneurship. ***Research Policy***, 41(7): 1240–1248.

Aldrich, H. E., & Fiol, C. M. 1994. Fools rush in? the institutional context of industry creation. ***Entrepreneurship: Concepts, Theory and Perspective***, 19(4): 105–127.

Aldrich, H. E., & Martinez, M. A. 2007. Many are called, but few are chosen: An evolutionary perspective for the study of entrepreneurship. ***Entrepreneurship Theory and Practice***, 25(4): 41–56.

Allison, T. H., Davis, B. C., Short, J. C., & Webb, J. W. 2015. Crowdfunding in a prosocial microlending environment: Examining the role of intrinsic versus extrinsic cues. ***Entrepreneurship Theory and Practice***, 39(1): 53–73.

Amit, R., & Zott, C. 2001. Value creation in e-business. ***Strategic Management Journal***, 22(6-7): 493–520.

Andersen, J. V., Lindberg, A., Lindgren, R., & Selander, L. 2016. Algorithmic Agency in Information Systems: Research Opportunities for Data Analytics of Digital Traces. ***Proceedings of the 49th Annual Hawaii International Conference on System Sciences***.

Andersson, S., & Wictor, I. 2003. Innovative internationalisation in new firms: born globals–the Swedish case. ***Journal of International Entrepreneurship***, 1(3): 249–275.

Ashcraft, K. L., Kuhn, T. R., & Cooren, F. 2009. Constitutional Amendments: "Materializing" Organizational Communication. ***The Academy of Management Annals***, 3(1): 1–64.

Ashforth, B. E., & Gibbs, B. W. 1990. The double-edge of organizational legitimation. ***Organization Science***, 1(2): 177–194.

Ashforth, B. E., Harrison, S. H., & Corley, K. G. 2008. Identification in organizations: An examination of four fundamental questions. ***Journal of Management***, 34(3): 325–374.

Ashforth, B. E., & Johnson, S. A. 2001. Which Hat to Wear? The Relative Salience of Multiple Identities in Organizational Contexts. In M. A. Hogg & D. J. Terry (Eds.), ***Social Identity Processes in Organizational Contexts***: 31–48. New York: Taylor & Francis Group.

Ashforth, B. E., & Mael, F. 1989. Social identity theory and the organization. ***Academy of Management Review***, 14(1): 20–39.

Audretsch, D. B., Aldridge, T. T., & Sanders, M. 2011. Social capital building and new business formation: A case study in Silicon Valley. ***International Small Business Journal***, 29(2): 152–169.

Austin, R. D., Devin, L., & Sullivan, E. E. 2011. Accidental Innovation: Supporting Valuable Unpredictability in the Creative Process. ***Organization Science***, 23(5): 1505–1522.

Avdeitchikova, S. 2008. On the structure of the informal venture capital market in Sweden: developing investment roles. ***Venture Capital***, 10(1): 55–85.

Avgerou, C., & Li, B. 2013. Relational and institutional embeddedness of Web-enabled entrepreneurial networks: case studies of netrepreneurs in China. ***Information Systems Journal***, 23(4): 329–350.

Avital, M., & Te'Eni, D. 2009. From generative fit to generative capacity: Exploring an emerging dimension of information systems design and task performance. ***Information Systems Journal***, 19(4): 345–367.

Axelrod, R., Mitchell, W., Thomas, R. E., Bennett, D. S., & Bruderer, E. 1995. Coalition formation in standard-setting alliances. ***Management Science***, 41(9): 1493–1508.

Bakos, Y., & Katsamakas, E. 2008. Design and Ownership of Two-Sided Networks: Implications for Internet Platforms. ***Journal of Management Information Systems***, 25(2): 171–202.

Baldwin, C. Y., & Clark, K. B. 1997. Managing in an age of modularity. ***Harvard Business Review***, 75(5): 84–93.

Baldwin, C. Y., & Clark, K. B. 2000. Design Rules: The Power of Modularity. ***Academy of Management Review***, 26: 471-488.

Baldwin, C. Y., & Clark, K. B. 2006. The Architecture of Participation: Does Code Architecture Mitigate Free Riding in the Open Source Development Model? ***Management Science***, 52(7): 1116–1127.

Baptista, J., Newell, S., & Currie, W. 2010. Paradoxical effects of institutionalisation on the strategic awareness of technology in organisations. ***Journal of Strategic Information Systems***, 19(3): 171–183.

Barber, B. 1995. All economies are" embedded": the career of a concept, and beyond. ***Social Research***, 387–413.

Baregheh, A., Rowley, J., & Sambrook, S. 2009. Towards a multidisciplinary definition of innovation. ***Management Decision***, 49(8): 1323–1339.

Barreto, I., & Baden-Fuller, C. 2006. To conform or to perform? Mimetic behaviour, legitimacy-based groups and performance consequences. ***Journal of Management Studies***, 43(7): 1559–1581.

Barrett, M., Oborn, E., & Orlikowski, W. J. 2016. Creating value in online communities: the sociomaterial configuring of strategy, platform, and stakeholder engagement. ***Information Systems Research***, 27(4): 704–723.

Baskerville, R. L., & Myers, M. D. 2009. Fashion waves in information systems research and practice. ***Mis Quarterly***, 33(4): 647–662.

Battilana, J., Leca, B., & Boxenbaum, E. 2009. How Actors Change Institutions: Towards a Theory of Institutional Entrepreneurship. ***The Academy of Management Annals***, 3(1): 65–107.

BBC. 2014, February 28. MtGox bitcoin exchange files for bankruptcy. ***BBC News***. http://www.bbc.com/news/technology-25233230, London. [Accessed November 22, 2014]

Beane, M., & Orlikowski, W. J. 2015. What Difference Does a Robot What Difference Does a Robot Make? The Material Enactment of Distributed Coordination. ***Organization Science***, 26(6): 1553–1573.

Beaulieu, T., & Sarker, S. 2013. Discursive Meaning Creation in Crowdfunding: A Socio-material Perspective. ***International Conference on Information Systems***. Milan.

Bechky, B. A. 2006. Talking about machines, thick description, and knowledge work. ***Organization Studies***, 27(12): 1757–1768.

Beck, C. J. 2008. The Contribution of Social Movement Theory to Understanding Terrorism. ***Sociology Compass***, 2(5): 1565–1581.

Beckert, J. 1999. Agency, Entrepreneurs, and Institutional Change. The Role of Strategic Choice and Institutionalized Practices in Organizations. ***Organization Studies***, 20(5): 777–799.

Beier, M., & Wagner, K. 2014. Crowdfunding between Social Media and E-Commerce: Online Communication, Online Relationships and Fundraising Success on Crowdfunding Platforms. ***SSRN Electronic Journal***.

Belleflamme, P., Lambert, T., & Schwienbacher, A. 2014. Crowdfunding: Tapping the right crowd. ***Journal of Business Venturing***, 29(5): 585–609.

Benbasat, I., & Wang, W. 2005. Trust in and adoption of online recommendation agents. ***Journal of the Association for Information Systems***, 6(3): 4.

Benner, M. M. J., & Tushman, M. 2002. Process management and technological innovation: A longitudinal study of the photography and paint industries. ***Administrative Science Quarterly***, 47(4): 676–706.

Bennett, W. L., & Segerberg, A. 2011. Digital Media and the Personalization of Collective Action: Social Technology and the Organization of Protests against the Global Economic Crisis. ***Information Communication & Society*** , 14(6): 770–799.

Benson, P. 2008. Good clean tobacco: Philip Morris, biocapitalism, and the social course of stigma in North Carolina. ***American Ethnologist***, 35(3): 357–379.

Bergquist, M., & Ljungberg, J. 2001. The power of gifts: Organizing social relationships in open source communities. ***Information Systems Journal***, 11: 305–320.

Björkdahl, J. 2009. Technology cross-fertilization and the business model: The case of integrating ICTs in mechanical engineering products. ***Research Policy***, 38(9): 1468–1477.

Blank, S. 2013. Why the lean start-up changes everything. ***Harvard Business Review***, 91(5): 63–72.

Blei, D. M., Ng, A. Y., & Jordan, M. I. 2003. Latent dirichlet allocation. ***The Journal of Machine Learning Research***, 3(1): 993–1022.

Boland, R. J., Lyytinen, K., & Yoo, Y. 2007. Wakes of Innovation in Project Networks: The Case of Digital 3-D Representations in Architecture, Engineering, and Construction. ***Organization Science***, 18(4): 631–647.

Bonaccorsi, A., & Rossi, C. 2003. Why open source software can succeed. ***Research Policy***, 32(7): 1243–1258.

Boudreau, K., & Lakhani, K. 2009. How to Manage Outside Innovation. ***MIT Sloan Management Review***, 50(4): 69.

Bourdieu, P. 1988. ***Homo academicus***. Stanford University Press.

Bowen, G. A. 2008. Naturalistic inquiry and the saturation concept: a research note. ***Qualitative research***, 8(1): 137–152.

Bowker, G. C. ., & Star, S. L. 2000. Sorting Things Out. ***Sorting Things Out: Classification and Its Consequences***.

Braa, J., Hanseth, O., Heywood, A., Woinshet, M., & Shaw, V. 2007. Developing Health Information Systems in Developing Countries : the flexible Standards Strategy. ***Management Information Systems Quarterly***, 31(Suppl 1): 381–402.

Braet, O., Spek, S., & Pauwels, C. 2013. Crowdfunding the movies: A business analysis of crowdfinanced moviemaking in small geographical markets. ***Journal of Media Business***

Studies, 10(1): 1–23.
Brito, J., & Castillo, A. 2013. ***Bitcoin: A Primer for Policymakers***. Arlington: Mercatus Center at George Mason University.
Broadbent, M., & Weill, P. 1997. Management by maxim: How business and IT managers can create IT infrastructures. ***Sloan Management Review***, 38(3): 77–92.
Broadbent, M., & Weill, P. 1998. ***Leveraging the new infrastructure***. Boston: Harvard Business School Press.
Broadbent, M., Weill, P., & Clair, D. S. 1999. The Implications of Information Technology Infrastructure for Business Process Redesign. ***MIS Quarterly***, 23(2): 159.
Bruton, G., Khavul, S., Siegel, D., & Wright, M. 2015. New Financial Alternatives in Seeding Entrepreneurship: Microfinance, Crowdfunding, and Peer-to-Peer Innovations. ***Entrepreneurship Theory and Practice***, 39(1): 9–26.
Bucar, B., & Hisrich, R. D. 2001. Ethics of business managers vs. entrepreneurs. ***Journal of Developmental Entrepreneurship***, 6(1): 59.
Bullough, A., & Renko, M. 2013. Entrepreneurial resilience during challenging times. ***Business Horizons***, 56(3): 343–350.
Burn-Callander, R., Stone, C., & Laurence, J. 2014. Five reasons why Bitcoin is the most dangerous currency in the world. ***The Telegraph***. [Accessed October 20, 2017]
Burt, R. S. 1993. The social structure of competition. ***Explorations in economic sociology***, 65: 103.
Burt, R. S. 2009. ***Structural holes: The social structure of competition***. Harvard university press.
Burtch, G., Ghose, A., & Wattal, S. 2013. An empirical examination of the antecedents and consequences of contribution patterns in crowd-funded markets. ***Information Systems Research***, 24(3): 499–519.
Buterin, V. 2013, April. The Bitcoin Crash: An Examination. ***BitcoinMagazine***. https://bitcoinmagazine.com/articles/the-bitcoin-crash-an-examination-1365911041. [Accessed October 20, 2017]
Callon, M. 1986. Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. In J. Law (Ed.), ***Power, action and belief: A new sociology of knowledge?*** 196–233. Routledge.
Caputo, M., & Zirpoli, F. 2002. Supplier involvement in automotive component design: outsourcing strategies and supply chain management. ***International Journal of Technology Management***, 23(1–3): 129–159.
Cardona, M., Kretschmer, T., & Strobel, T. 2013. ICT and productivity: conclusions from the empirical literature. ***Information Economics and Policy***, 25(3): 109–125.
Cargill, C. F. 1989. ***Information technology standardization: theory, process, and organizations***. Digital Press.
Casper, S., & Whitley, R. 2004. Managing competences in entrepreneurial technology firms: a comparative institutional analysis of Germany, Sweden and the UK. ***Research Policy***, 33(1): 89–106.
Cassell, J., & Bickmore, T. 2000. External manifestations of trustworthiness in the interface. ***Communications of the ACM***, 43(12): 50–56.
Chesbrough, H. W. 2003. The Era of Open Innovation. ***MIT Sloan management review***, 44(3): 35–41. Chesbrough, H. W. 2006. ***Open Business Models: How to Thrive in the New Innovation Landscape***. Harvard Business Press.
Cheshire, T. 2011. Europe's hottest startup capitals: Stockholm (Wired UK). ***Wired UK***. [Accessed November 22, 2014]
Chia, R., & Holt, R. 2006. Strategy as practical coping: a Heideggerian perspective. ***Organization Studies***, 27(5): 635–655.
Child, J. 1997. Strategic Choice in the Analysis of Action, Structure, Organizations and

Environment: Retrospect and Prospect. ***Organization Studies***, 18(1): 43–76.

Choi, N., Chengalur-Smith, I., & Nevo, S. 2015. Loyalty, Ideology, and Identification: An Empirical Study of the Attitudes and Behaviors of Passive Users of Open Source Software. ***Journal of the Association for Information Systems***, 16(8): 674–706.

Christin, N. 2013. Traveling the Silk Road: A Measurement Analysis of a Large Anonymous Online Marketplace. ***WWW 20133***: 213–223. Rio de Janeiro, Brazil.

Chuang, J., Manning, C. D., & Heer, J. 2012. Termite : Visualization Techniques for Assessing Textual Topic Models Categories and Subject Descriptors. ***International Conference on Advanced Visual Interfaces (AVI)***.

Ciborra, C. 2000. ***From control to drift: the dynamics of corporate information infastructures***. Oxford University Press on Demand.

Cloutier, C., & Langley, a. 2013. The Logic of Institutional Logics: Insights From French Pragmatist Sociology. ***Journal of Management Inquiry***, 22(4): 360–380.

Cohen, W. M., & Levinthal, D. A. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. ***Administrative Science Quarterly***, 35(1): 128–152.

Colombo, M. G., Franzoni, C., & Rossi-Lamastra, C. 2015. Internal social capital and the attraction of early contributions in crowdfunding. ***Entrepreneurship Theory and Practice***, 39(1): 75–100.

Colomy, P., & Rhoades, G. 1994. Toward a micro corrective of structural differentiation theory. ***Sociological Perspectives***, 37(4): 547–583.

Colyvas, J. A., & Powell, W. W. 2006. Roads to Institutionalization: The Remaking of Boundaries between Public and Private Science. ***Research in Organizational Behavior***, 27: 305–353.

Corbin, J. M., & Strauss, A. 1990. ***Grounded theory research: Procedures, canons, and evaluative criteria***. ***Qualitative Sociology***. London: Sage.

Corritore, C. L., Kracher, B., & Wiedenbeck, S. 2003. On-line trust: concepts, evolving themes, a model. ***International Journal of Human-Computer Studies***, 58(6): 737–758.

Cross, R., Cowen, A., Vertucci, L., & Thomas, R. J. 2009. Leading in a Connected World:. How Effective Leaders Drive Results Through Networks. ***Organizational Dynamics***, 38(2): 93–105.

Cusumano, M. A., & Gawer, A. 2002. The elements of platform leadership. ***MIT Sloan Management Review***, 43(3): 51.

Czernich, C. 2004. ***When Ideas meet Organizations The survival of entrepreneurial ventures inside the established firm***.

Dacin, M. T., Goodstein, J., & Scott, W. R. 2002. Institutional theory and institutional change: Introduction to the special research forum. ***Academy of Management Journal***, 45(1): 45–57.

Dacin, M. T., Ventresca, M. J., & Beal, B. D. 1999. The embeddedness of organizations: Dialogue & directions. ***Journal of management***, 25(3): 317–356.

Dahlander, L., & Magnusson, M. G. 2005. Relationships between open source software companies and communities: Observations from Nordic firms. ***Research Policy***, 34(4): 481–493.

Dahlander, L., & O'Mahony, S. 2011. Progressing to the Center: Coordinating Project Work. ***Organization Science***, 22(4): 961–979.

Dallyn, S. 2017. Cryptocurrencies as market singularities: the strange case of Bitcoin. ***Journal of Cultural Economy***, 1–12.

Dart, R. 2004. The legitimacy of social enterprise. ***Nonprofit management and leadership***, 14(4): 411–424.

Davidson, E., & Vaast, E. 2010. Digital entrepreneurship and its sociomaterial enactment. ***Proceedings of the Annual Hawaii International Conference on System Sciences***: 1–10.

Davidsson, P. 2007. Strategies for dealing with heterogeneity in entrepreneurship research. ***Academy of Management Annual Meeting***. Philadelphia: Academy of Management.

Davidsson, P., & Findahl, O. 2016. ***Svenskarna och internet 2016***. https://www.iis.se/docs/Svenskarna_och_internet_2016.pdf, August 7, 2017, Stockholm. [Accessed November 8, 2017]

Davidsson, P., Low, M. B., & Wright, M. 2001. Editors's Introduction, Low and MacMillan ten year on achievement and future direction for entrepreneurship research. ***Entrepreneurship Theory and Practice***, 25(4): 5–16.

Davidsson, P., & Wiklund, J. 2001. Levels of analysis in entrepreneurship research: Current research practice and suggestions for the future. ***Entrepreneurship theory and Practice***, 25(4): 81–100.

Davison, R. M., Ou, C. X. J., & Martinsons, M. G. 2013. Information technology to support informal knowledge sharing. ***Information Systems Journal***, 23(1): 89–109.

de Vaujany, F.-X., & Vaast, E. 2014. If these walls could talk: the mutual construction of organizational space and legitimacy. ***Organization Science***, 25(3): 713–731.

Deephouse, D. D. L., & Suchman, M. 2008. Legitimacy in organizational institutionalism. ***The Sage handbook of organizational institutionalism***: 77.

Deephouse, D. L. 1996. Does isomorphism legitimate? ***Academy of Management Journal***, 39(4): 1024–1039.

DeNardis, L. 2012. Hidden levers of Internet control: An infrastructure-based theory of Internet governance. ***Information, Communication & Society***, 15(5): 720–738.

Dequech, D. 2003. Cognitive and Cultural Embeddedness: Combining Institutional Economics and Economic Sociology. ***Journal of Economic Issues***, 2(June): 461–470.

Devers, C. E., Dewett, T., Mishina, Y., & Belsito, C. a. 2009. A General Theory of Organizational Stigma. ***Organization Science***, 20(1): 154–171.

Dew, N., Read, S., Sarasvathy, S. D., & Wiltbank, R. 2009. Effectual versus predictive logics in entrepreneurial decision-making: Differences between experts and novices. ***Journal of Business Venturing***, 24(4): 287–309.

Dey, P., & Steyaert, C. 2010. The politics of narrating social entrepreneurship. ***Journal of Enterprising Communities: People and Places in the Global Economy***, 4(1): 85–108.

Dhanarag, C., & Parkhe, A. 2006. Orchestrating Innovation Networks. ***Academy of Management Review***, 31(3): 659–669.

DiMaggio, P. J., & Powell, W. W. 1983. The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. ***American Sociological Review***, 48(2): 147–160.

Dobrev, S. D. 2001. Revisiting organizational legitimation: Cognitive diffusion and sociopolitical factors in the evolution of Bulgarian newspaper enterprises, 1846-1992. ***Organization studies***, 22(3): 419–444.

Dougherty, C., & Huang, G. 2014, February 28. Mt. Gox Seeks Bankruptcy After $480 Million Bitcoin Loss. ***BloombergBusiness***. http://www.bloomberg.com/news/articles/2014-02-28/mt-gox-exchange-files-for-bankruptcy, New York. [Accessed November 22, 2014]

Dougherty, D., & Dunne, D. D. 2012. Digital Science and Knowledge Boundaries in Complex Innovation. ***Organization Science***, 23(5): 1467–1484.

Drori, I., Honig, B., & Sheaffer, Z. 2009. The life cycle of an internet firm: Scripts, legitimacy, and identity. ***Entrepreneurship: Theory and Practice***, 33(3): 715–738.

Durand, R., & Vergne, J. P. 2014. Asset divestment as a response to media attacks in stigmatized industries. ***Strategic Management Journal***, 36(8): 1205–1223.

Dwyer, P. 2017, July 20. Should America's Tech Giants Be Broken Up? - Bloomberg. ***Bloomberg Business Week***. https://www.bloomberg.com/news/articles/2017-07-20/should-america-s-tech-giants-be-broken-up, [Accessed November 22, 2017].

Eaton, B., Elaluf-Calderwood, S., Sørensen, C., & Yoo, Y. 2015. Distributed Tuning of

Boundary Resources: the Case of Apple's Ios Service System. ***MIS Quarterly***, 39(1): 217–243.

Edwards, P. N., Jackson, S. J., Bowker, G. C., & Knobel, C. 2007. ***Understanding infrastructure: Dynamics, tensions, and design. Report of a Workshop on "History & Theory of Infrastructure: Lessons for New Scientific Cyberinfrastructures."***

Eisenhardt, K. M. 1989. Building Theories from Case Study Research. ***Academy of Management Review***, 14(4): 532–550.

Eisenhardt, K. M., & Schoonhoven, C. B. 1996. Resource-based View of Strategic Alliance Formation: Strategic and Social Effects in Entrepreneurial Firms. ***Organization Science***, 7(2): 136–150.

Eisenmann, T., Parker, G., & Van Alstyne, M. 2011. Platform envelopment. ***Strategic Management Journal***, 32(12): 1270–1285.

Elfring, T., & Hulsink, W. 2003. Networks in Entrepreneurship: The Case of High-technology Firms. ***Small Business Economics***, 21: 409–422.

Erikson, T. 2001. "The Promise of Entrepreneurship As a Field of Research": A Few Comments and Some Suggested Extensions. ***Academy of Management Review***, 26(1): 12–13.

Erikson, T. 2002. Entrepreneurial capital: The emerging venture's most important asset and competitive advantage. ***Journal of Business Venturing***, 17(3): 275–290.

Ettlie, J. E., & Reza, E. M. 1992. Organizational integration and process innovation. ***Academy of Management Journal***, 35(4): 795–827.

Evans, D. S. 2003. Some empirical aspects of multi-sided platform industries. ***Review of Network Economics***, 2(3).

Evans, D. S. 2009. How catalysts ignite: the economics of platform-based start-ups. In A. Gawer (Ed.), ***Platforms, Markets and Innovation***. Cheltenham, UK and Northampton, MA, US: Edward Elgar Publishing.

Eyal, I., & Sirer, E. G. 2014. Majority is not enough: Bitcoin mining is vulnerable. ***International Conference on Financial Cryptography and Data Security***: 436–454. Springer.

Eyles, J., & Fried, J. 2012. The Anatomy of a Brand: Shaping Nuclear Discourse to Create the Perception of a "Clean World." ***Risk, Hazards & Crisis in Public Policy***, 3(1): 1–27.

Fadel, K. J., Meservy, T. O., & Jensen, M. L. 2015. Exploring Knowledge Filtering Processes in Electronic Networks of Practice. ***Journal of Management Information Systems***, 31(4): 158–181.

Fang, Y., & Neufeld, D. 2009. Understanding Sustained Participation in Open Source Software Projects. ***Journal of Management Information Systems***, 25(4): 9–50.

Faraj, S., & Azad, B. 2012. Materiality and organizing social interaction in a technological world. In P. M. Leonardi, B. A. Nardi, & J. Kallinikos (Eds.), ***Materiality and Organizing: Social Interaction in a Technological World***: 237–258. Oxford: Oxford University Press.

Feldman, M. S., & March, J. G. 1981. Information in organizations as signal and symbol. ***Administrative Science Quarterly***, 171–186.

Feller, J., Finnegan, P., Fitzgerald, B., & Hayes, J. 2008. From peer production to productization: A study of socially enabled business exchanges in open source service networks. ***Information Systems Research***, 19(4): 475–493.

Fligstein, N. 1991. The structural transformation of American industry: An institutional account of the causes of diversification in the largest firms, 1919-1979. ***The new institutionalism in organizational analysis***, 311.

Fligstein, N. 1996. Markets as politics: A political-cultural approach to market institutions. ***American sociological review***, 656–673.

Foray, D. 1994. Users, standards and the economics of coalitions and committees. ***Information Economics and Policy***, 6(3): 269–293.

Friedman, B., Khan Jr, P. H., & Howe, D. C. 2000. Trust online. ***Communications of the***

ACM, 43(12): 34–40.
Frydrych, D., Bock, A. J., Kinder, T., & Koeck, B. 2014. Exploring entrepreneurial legitimacy in reward-based crowdfunding. ***Venture Capital***, 16(3): 247–269.
Galuszka, P., & Bystrov, V. 2014. The rise of fanvestors: A study of a crowdfunding community. ***First Monday***, 19(5).
Gans, J. S., & Stern, S. 2003. The product market and the market for "ideas": Commercialization strategies for technology entrepreneurs. ***Research Policy***, 32(2): 333–350.
Garg, R., Smith, M. D., & Telang, R. 2011. Measuring Information Diffusion in an Online Community. ***Journal of Management Information Systems***, 28(2): 11–37.
Garrahan, M. 2016, June 23. Advertising: Facebook and Google build a duopoly. ***Financial Times***. [Accessed November 7, 2017]
Garud, R., Jain, S., & Kumaraswamy, A. 2002. Institutional entrepreneurship in the sponsorship of common technological standards: The case of Sun Microsystems and Java. ***Academy of Management Journal***, 45(1): 196–214.
Garud, R., & Karnøe, P. 2003. Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. ***Research policy***, 32(2): 277–300.
Garud, R., Karnøe, P., & Kumaraswamy, A. 2010. Path dependence or path creation? ***Journal of Management Studies***, 47(4): 760–774.
Garud, R., Schildt, H., & Lant, T. 2014. Entrepreneurial Storytelling, Future Expectations, and the Paradox of Legitimacy. ***Organization Science***, 25(5): 1479–1492.
Gaskin, J., Berente, N., Lyttinen, K., & Yoo, Y. 2014. Towards Generalizable Sociomaterial Inquiry: A Computational Approach for Zooming In and Out of Sociomaterial Routines. ***MIS Quarterly***, 38(3): 849–871.
Gawer, A., & Cusumano, M. A. 2014. Industry platforms and ecosystem innovation. ***Journal of Product Innovation Management***, 31(3): 417–433.
Geels, F. W. 2004. From sectoral systems of innovation to socio-technical systems. ***Research Policy***, 33(6–7): 897–920.
Gefen, D., Benbasat, I., & Pavlou, P. A. 2008. A research agenda for trust in online environments. ***Journal of Management Information Systems***, 24(4): 275–286.
Gefen, D., Karahanna, E., & Straub, D. W. 2003. Trust and TAM in online shopping: an integrated model. ***MIS quarterly***, 27(1): 51–90.
Ghazawneh, A., & Henfridsson, O. 2010. Governing third-party development through platform boundary resources. ***the International Conference on Information Systems (ICIS)***: 1–18. AIS Electronic Library (AISeL).
Ghazawneh, A., & Henfridsson, O. 2013. Balancing platform control and external contribution in third-party development: The boundary resources model. ***Information Systems Journal***, 23(2): 173–192.
Gherardi, S. 2009. Introduction: The Critical Power of the `Practice Lens'. ***Management Learning***, 40(2): 115–128.
Gibbert, M., Ruigrok, W., & Wicki, B. 2008. What passes as a rigorous case study? ***Strategic Management Journal***, 29: 1465–1474.
Giddens, A. 1984. ***The constitution of society: Outline of the theory of structuration***. Univ of California Press.
Gigerenzer, G., & Gaissmaier, W. 2011. Heuristic Decision Making. ***Annual Review of Psychology***, 62(1): 451–482.
Ginsberg, A., & Hay, M. 1994. Confronting the challenges of corporate entrepreneurship: Guidelines for venture managers. ***European Management Journal***, 12(4): 382–389.
Glaser, B. G. 1992. ***Emergence vs forcing: Basics of grounded theory analysis***. Sociology Press.
Glaser, B. G., & Strauss, A. L. 1999. ***The Discovery of Grounded Theory: Strategies for qualitative research***. New Brunswick: AldineTransaction.

Glynn, M. A. 2000. When Cymbals become Symbols: Conflict over Organizational Identity within a Symphony Orchestra. ***Organization Science***, 11(3): 285–298.

Gnyawali, D. R., & Madhavan, R. 2001. Cooperative Networks and Competitive Dynamics: A Structural Embeddedness Perspective. ***Academy of Management Review***, 26(3): 431–445.

Goh, J. M., Gao, G. G., & Agarwal, R. 2011. Evolving Work Routines : Adaptive Routinization of Information Technology in Healthcare ***Information Systems Research***, 22(3), 565-585.

Goh, K.-Y., Heng, C.-S., & Lin, Z. 2013. Social Media Brand Community and Consumer Behavior: Quantifying the Relative Impact of User- and Marketer-Generated Content. ***Information Systems Research***, 24(1): 88–107.

Goodin, D. 2013. Study: More than 1 percent of Google Play apps are "aggressive" copycats | Ars Technica. ***Ars Technica***. http://arstechnica.com/security/2013/11/study-more-than-1-percent-of-google-play-apps-are-aggressive-copycats/. [Accessed November 14, 2017]

Goodstein, J. D. 1994. Institutional pressures and strategic responsiveness: Employer involvement in work-family issues. ***Academy of Management Journal***, 37(2): 350–382.

Gosain, S. 2004. Enterprise information systems as objects and carriers of institutional forces: the new iron cage? ***Journal of the Association for Information Systems***, 5(4): 6.

Graebner, M. E., & Eisenhart, K. M. 2007. Theory building from cases: Opportunities and challenges. ***Academy of Management Journal***, 50(1): 25–32.

Granovetter, M. 1985. Economic action and social structure: The problem of embeddedness. ***American Journal of Sociology***, 481–510.

Granovetter, M. 1992. Economic institutions as social constructions: a framework for analysis. ***Acta Sociologica***, 35(1): 3–11.

Grant, R. M., & Baden-Fuller, C. 1995. A knowledge-based theory of inter-firm collaboration. ***Academy of Management Proceedings***: 17–21. Academy of Management.

Greenstein, S., Lerner, J., & Stern, S. 2013. Digitization, innovation, and copyright: What is the agenda? ***Strategic Organization***, 11(1): 110–121.

Greenstein, S. M. 1992. Invisible hands and visible advisors: An economic interpretation of standardization. ***Journal of the American Society for Information Science (1986-1998)***, 43(8): 538.

Greenwood, R., & Suddaby, R. 2006. Institutional entrepreneurship in mature fields: The big five accounting firms. ***Academy of Management Journal***, 49(1): 27–48.

Greenwood, R., Suddaby, R., & Hinings, C. R. 2002. Theorizing change: The role of professional associations in the transformation of institutional fields. ***Academy of Management Journal***, 45(1): 58.

Grégoire, D. a., Noël, M. X., Déry, R., & Béchard, J. P. 2006. Is there conceptual convergence in entrepreneurship research? A co-citation analysis of Frontiers Entrepreneurship Research, 1981-2004. ***Entrepreneurship: Theory and Practice***, 30(3): 333–373.

Grewal, R., Lilien, G. L., & Mallapragada, G. 2006. Location, Location, Location: How Network Embeddedness Affects Project Success in Open Source Systems. ***Management Science***, 52(7): 1043–1056.

Griffiths, T. L., & Steyvers, M. 2004. Finding scientific topics. ***Proceedings of the National Academy of Sciences of the United States of America***, 101(1): 5228–5235.

Grover, V., Purvis, R. L., & Segars, A. H. 2007. Exploring ambidextrous innovation tendencies in the adoption of telecommunications technologies. ***IEEE Transactions on Engineering Management***, 54(2): 268–285.

Gruber, M., & Henkel, J. 2006. New ventures based on open innovation an empirical analysis of start-up firms in embedded Linux. ***International Journal of Technology Management***, 33(4): 356.

Gulati, R. 1995. Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. ***Academy of management journal***, 38(1): 85–112.

Gulati, R., Nohria, N., & Zaheer, a. 2000. Guest editors' introduction to the special issue: Strategic networks. ***Strategic Management Journal***, 21(3): 199–201.

Gupta, A. K., & Govindarajan, V. 2000. Knowledge flows within multinational corporations. ***Strategic management journal***, 21(4): 473–496.

Haefliger, S., Von Krogh, G., & Spaeth, S. 2008. Code reuse in open source software. ***Management Science***, 54(1): 180–193.

Hagedoorn, J. 2006. Understanding the cross-level embeddedness of interfirm partnership formation. ***Academy of Management Review***, 31(3): 670–680.

Halinen, A., & Törnroos, J.-Å. 1998. The Role of Embeddedness in the Evolution of Business Networks. ***Scandinavian Journal of Management***, 14(3): 187–205.

Hanseth, O. 2000. The Economics of Standards. In K. Ciborra, C., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E. and Simon (Ed.), ***From Control to Drift. The Dynamics of Corporate Information Infrastructures,***: 56–70. Oxford: Oxford University Press.

Hanseth, O., & Aanestad, M. 2003. Design as bootstrapping. On the evolution of ICT networks in health care. ***Methods of information in medicine***, 42(4): 384–391.

Hanseth, O., & Bygstad, B. 2015. Flexible generification: ICT standardization strategies and service innovation in health care. ***European Journal of Information Systems***, 24(1).

Hanseth, O., Jacucci, E., Grisot, M., & Aanestad, M. 2006. Reflexive Standardization: Side Effects and Complexity in Standard Making, 30: 563–581.

Hanseth, O., & Lyytinen, K. 2010. Design theory for dynamic complexity in information infrastructures: the case of building internet. ***Journal of Information Technology***, 25(1):

Hanseth, O., & Monteiro, E. 1997. Inscribing behaviour in information infrastructure standards. ***Accounting, Management and Information Technologies***, 7(4): 183–211.

Hardt, M., & Negri, A. 2011. The fight for'Real democracy'at the heart of Occupy Wall Street. ***Foreign Affairs***, 11: 2011.

Hardy, C., & Maguire, S. 2008. ***Institutional entrepreneurship***. ***The Sage handbook of organizational institutionalism***. Thousand Oaks, CA: Sage Publications.

Hargadon, A., & Sutton, R. I. 1997. Technology brokering and innovation in a product development firm. ***Administrative science quarterly***, 716–749.

Hargrave, T. J., & van de Ven, A. H. 2006. A Collective Action Model of Instituional Innovation. ***Academy of Management Review***, 31(4): 864–888.

Harrison, J. S., & Freeman, R. E. 1999. Stakeholders, social responsibility, and performance: Empirical evidence and theoretical perspectives. ***Academy of Management Journal***, 42(5): 479–485.

Haveman, H. A. 1993. Follow the leader: Mimetic isomorphism and entry into new markets. ***Administrative science quarterly***, 593–627.

Hearn, M. 2015. Why is Bitcoin forking? A tale of differing visions. https://medium.com/faith-and-future/why-is-bitcoin-forking-d647312d22c1#.8dq5fi3we. [Accessed February 25, 2016]

Hedman, J., Srinivisan, N., & Lindgren, R. 2013. Digital Traces of Information Systems: Sociomateriality Made Researchable. ***Thirty Fourth International Conference on Information Systems, Milan 2013***: 809–830.

Heinrich, L. J., & Riedl, R. 2013. Understanding the dominance and advocacy of the design-oriented research approach in the business informatics community: a history-based examination. ***Journal of Information Technology***, 28(1, SI): 34–49.

Helms, R., Giovacchini, E., Teigland, R., & Kohler, T. 2010. A Design Research Approach to Developing User Innovation Workshops in Second Life. ***Journal of Virtual Worlds Research***, 3(1): 3–36.

Henfridsson, O., & Bygstad, B. 2013. The generative mechanisms of digital infrastructure evolution. ***MIS Quarterly***, 37(3): 907–931.

Henfridsson, O., Mathiassen, L., & Svahn, F. 2014. Managing technological change in the digital age: The role of architectural frames. ***Journal of Information Technology***, 29(1).

Henfridsson, O., & Yoo, Y. 2014. The Liminality of Trajectory Shifts in Institutional Entrepreneurship. ***Organization Science***, 25(3): 932–950.

Hensmans, M. 2003. Social Movement Organizations: A Metaphor for Strategic Actors in Institutional Fields. ***Organization Studies***, 24(3): 355–381.

Herzhoff, J. 2009. The ICT convergence discourse in the information systems literature-A second-order observation. ***17th European Conference on Information Systems***. Verona, Italy.

Herzhoff, J. D. 2014. ***Unfolding the Convergence Paradox: The Case of Mobile Voice-over-IP in the UK***. London School of Economics.

Herzhoff, J. D., Elaluf-Calderwood, S. M., & Sørensen, C. 2010. Convergence, conflicts, and control points: A systems-theoretical analysis of mobile VoIP in the UK. ***Mobile Business and 2010 Ninth Global Mobility Roundtable (ICMB-GMR), 2010 Ninth International Conference on***: 416–424. IEEE.

Hewitt, A., & Forte, A. 2006. Crossing boundaries: Identity management and student/faculty relationships on Facebook. ***Poster presented at CSCW Banff Alberta***, 38: 1–2.

Hilsenrath, J. 2010. Lost Faith in Institutions Hurts U.S. Outlook. ***Wall Street Journal***.

Hippel, E. Von, & Krogh, G. Von. 2003. Open Source Software and the "Private-Collective" Model: Innovation Issues for Organization Science. ***Organization Science***, 14(2): 209–223.

Hite, J. M. 2003. Patterns of multidimensionality among embedded network ties: a typology of relational embeddedness in emerging entrepreneurial firms. ***Strategic Organization***, 1(1): 9–49.

Hoffman, A. J., & Ventresca, M. J. 1999. The institutional framing of policy debates economics versus the environment. ***American Behavioral Scientist***, 42(8): 1368–1392.

Hofstede, G. 1980. Motivation, leadership, and organization: do American theories apply abroad? ***Organizational dynamics***, 9(1): 42–63.

Hofstede, G. 2011. Dimensionalizing Cultures : The Hofstede Model in Context. ***Online Readings in Psychology and Culture***, 2: 1–26.

Holland, J. H. 1995. ***Hidden order: How adaptation builds complexity***. BOOK, Basic Books.

Howison, J., Wiggins, A., & Crowston, K. 2011. Validity Issues in the Use of Social Network Analysis with Digital Trace Data. ***Journal of the Association for Information Systems***, 12(12): 767–797.

Hsiao, R.-L., Tsai, S. D.-H., & Lee, C.-F. 2006. The problems of embeddedness: knowledge transfer, coordination and reuse in information systems. ***Organization Studies***, 27(9): 1289–1317.

Hudson, B. A., & Okhuysen, G. A. 2009. Not with a ten-foot pole: Core stigma, stigma transfer, and improbable persistence of men's bathhouses. ***Organization Science***, 20(1): 134–153.

Iannacci, F. 2010. When is an information infrastructure? Investigating the emergence of public sector information infrastructures. ***European Journal of Information Systems***, 19(1): 35–48.

Ingram, C., & Morisse, M. 2016. Almost an MNC: Bitcoin Entrepreneurs' Use of Collective Resources and Decoupling to Build Legitimacy. ***2016 49th Hawaii International Conference on System Sciences (HICSS)***: 4083–4092. IEEE.

Ingram, P., & Clay, K. 2000. The Choice-Within-Constraints New Institutionalism and Implications for Sociology. ***Annual Review of Sociology***.

Inkpen, A. C. 2000. Learning through joint ventures: a framework of knowledge acquisition. ***Journal of Management Studies***, 37(7): 1019–1044.

Ivarsson, M. 2008. Are Swedish consumers willing to pay for sustainability and solidarity?

Jacobson, C. K., Lenway, S. A., & Ring, P. S. 1993. The political embeddedness of private economic transactions. ***Journal of Management Studies***, 30(3): 453–478.

Jahanshahi, M. F. 1998. The US railroad industry and open access. ***Transport Policy***, 5(2): 73–81.

Jarvenpaa, S. L., Knoll, K., & Leidner, D. E. 1998. Is anybody out there? Antecedents of trust in global virtual teams. ***Journal of management information systems***, 14(4): 29–64.

Jarzabkowski, P. a. 2004. Strategy as practice: recursiveness, adaptation, and practices-in-use. ***Organization Studies***, 25(4): 529–560.

Jarzabkowski, P., & Paul Spee, A. 2009. Strategy-as-practice: A review and future directions for the field. ***International Journal of Management Reviews***, 11(1): 69–95.

Jenkins, R. 2000. Categorization: Identity, social process and epistemology. ***Current sociology***, 48(3): 7–25.

Jian, L., & Usher, N. 2014. Crowd-Funded Journalism. ***Journal of Computer-Mediated Communication***, 19(2): 155–170.

Jiwa, S., Lavelle, D., & Rose, A. 2004. Netrepreneur simulation: enterprise creation for the online economy. ***International Journal of Retail & Distribution Management***, 32(12): 587–596.

Johannisson, B. 2008. The social construction of the disabled and unfashionable family business. In V. Gupta, N. Levenburg, L. L. Moore, J. Motwani, & T. V. Schwarz (Eds.), ***Culturally-sensitive models of family business in Nordic Europe: A compendium using the globe paradigm***: 125–144. Hyderabad: ICFAI University Press.

Johannisson, B. 2011. Towards a practice theory of entrepreneuring. ***Small Business Economics***, 36(2): 135–150.

Johnson, D. W., & Johnson, R. T. 1996. Cooperation and the use of technology. ***Handbook of research for educational communications and technology: A project of the Association for Educational Communications and Technology***, 1017–1044.

Johnson, J. L., Cullen, J. B., Sakano, T., & Takenouchi, H. 1996. Setting the stage for trust and strategic integration in Japanese-US cooperative alliances. ***Journal of International Business Studies***, 981–1004.

Johnson, S. L., Faraj, S., & Kudaravalli, S. 2014. Emergence of Power Laws in Online Communities: The role of Social Mechanisms and Preferential Attachment. ***MIS Quarterly***, 38(3): 795-U237.

Jonsson, S., & Buhr, H. 2011. The Limits of Media Effects: Field Positions and Cultural Change in a Mutual Fund Market. ***Organization Science***, 22(2): 464–481.

Kaish, S., & Gilad, B. 1991. Characteristics of opportunities search of entrepreneurs versus executives: Sources, interests, general alertness. ***Journal of Business Venturing***, 6(1): 45–61.

Kallinikos, J., Aaltonen, A., & Marton, A. 2010. A theory of digital objects. ***First Monday***, 15(6).

Kallinikos, J., Aaltonen, A., & Marton, A. 2013. The Ambivalent Ontology of Digital Artifacts. ***MIS Quarterly***, 34(2): 213–231.

Kaplan, A. M., & Haenlein, M. 2010. Users of the world, unite! The challenges and opportunities of Social Media. ***Business Horizons***, 53(1): 59–68.

Karlstrøm, H. 2014. Do libertarians dream of electric coins? The material embeddedness of Bitcoin. ***Distinktion: Scandinavian Journal of Social Theory***, 15(1): 23–36.

Karnøe, P. 1996. The social process of competence building. ***International Journal of Technology Management***, 11(7–8): 770–789.

Kartseva, V., Hulstijn, J., Gordijn, J., & Tan, Y.-H. 2010. Control patterns in a health-care network. ***European Journal of Information Systems***, 19(3): 320–343.

Katz, M. L., & Shapiro, C. 1994. Systems competition and Network effects. ***Journal of Economic Perspectives***, 8(2): 93–115.

Keen, P., & Williams, R. 2013. Value architectures for digital business: beyond the business

model. ***Mis Quarterly***, 37(2): 642–647.

Keller, E., Szefer, J., Rexford, J., & Lee, R. B. 2010. NoHype: virtualized cloud infrastructure without the virtualization. ***ACM SIGARCH Computer Architecture News***: 350–361. ACM.

Kellogg, K. C. 2011. Hot Lights and Cold Steel: Cultural and Political Toolkits for Practice Change in Surgery. ***Organization Science***, 22(2): 482–502.

Kenney, M., & Goe, W. R. 2004. The role of social embeddedness in professorial entrepreneurship: a comparison of electrical engineering and computer science at UC Berkeley and Stanford. ***Research Policy***, 33(5): 691–707.

Kerr, W. R., Lerner, J., & Schoar, A. 2014. The consequences of entrepreneurial finance: Evidence from angel financings. ***Review of Financial Studies***, 27(1): 20–55.

Kirsch, L. S. 1997. Portfolios of control modes and IS project management. ***Information Systems Research***, 8(3): 215–239.

Kitagaki, I., & Hikita, A. 2007. Development of an algorithm for groupware modeling for a collaborative learning. ***International Journal of Computers, Communications & Control***, 1.

Knorr-Cetina, K. 1999. ***Epistemic communities.*** Harvard: Harvard Educational.

Koning, R. M., & Model, J. 2014. Experimental study of crowdfunding cascades: When nothing is better than something. ***Academy of Management Proceedings***: 16683. Academy of Management.

Korsgaard, S., & Anderson, A. R. 2011. Enacting entrepreneurship as social value creation. ***International Small Business Journal***, 29(2): 135–151.

Koufaris, M., & Hampton-Sosa, W. 2004. The development of initial trust in an online company by new customers. ***Information & management***, 41(3): 377–397.

Kreiner, G. E., Hollensbe, E. C., & Sheep, M. L. 2006. Where is the "me" among the "we"? Identity work and the search for optimal balance. ***Academy of Management Journal***, 49(5): 1031–1057.

Kuk, G., & Janssen, M. 2013. Assembling infrastructures and business models for service design and innovation. ***Information Systems Journal***, 23(5): 445–469.

Kuo, P.-Y., & Gerber, E. 2012. Design principles: crowdfunding as a creativity support tool. ***Proceedings of the 2012 ACM annual conference extended abstracts on Human Factors in Computing Systems Extended Abstracts - CHI EA '12***: 1601. New York, New York, USA: ACM Press.

Kurzman, C. 2008. Introduction: Meaning-Making in Social Movements. ***Anthropological Quarterly***, 81(1): 5–15.

Lakhani, K. R., & Panetta, J. a. 2007. The Principles of Distributed Innovation. ***Innovations: Technology, Governance, Globalization***, 2(3): 97–112.

Lakhani, K. R., & Von Hippel, E. 2003. How open source software works:"free" user-to-user assistance. ***Research policy***, 32(6): 923–943.

Lamin, A., & Zaheer, S. 2012. Wall Street vs. Main Street: Firm Strategies for Defending Legitimacy and Their Impact on Different Stakeholders. ***Organization Science***, 23(1): 47–66.

Landstrom, H. 1995. Decision-Making Behavior by Informal Investors in Sweden. ***Journal of Small Business Management***, (July): 67–76.

Langley, A. 1999. Strategies for Theorizing from Process Data. ***Academy of Management Review***, 24(4): 691–710.

Langlois, R. N. 1992. External economies and economic progress: The case of the microcomputer industry. ***Business History Review***, 66(1): 1–50.

Langlois, R. N. 2002. Modularity in technology and organization. ***Journal of Economic Behavior & Organization***, 49(1): 19–37.

Latour, B. 1987. ***Science in action: How to follow scientists and engineers through society***.

Harvard: Harvard University Press.
Lave, J., & Wenger, E. 1991. ***Situated learning: Legitimate peripheral participation***., CAmbridge: Cambridge University Press.
Leca, B., & Naccache, P. 2006. A Critical Realist Approach To Institutional Entrepreneurship. ***Organization***, 13(5): 627–651.
Lee, B. H., Hiatt, S. R., & Lounsbury, M. 2017. Market Mediators and the Trade-offs of Legitimacy-Seeking Behaviors in a Nascent Category. ***Organization Science***, 28(3): 447–470.
Lee, E., & Lee, B. 2012. Herding behavior in online P2P lending: An empirical investigation. ***Electronic Commerce Research and Applications***, 11(5): 495–503.
Lee, G. K., & Cole, R. E. 2003. From a Firm-Based to a Community-Based Model of Knowledge Creation: The Case of the Linux Kernel Development. ***Organization Science***, 14(6): 633–649.
Lehner, O. M. 2013. Crowdfunding social ventures: a model and research agenda. ***Venture Capital***, 15(4): 289–311.
Leimeister, J. M., Ebner, W., & Krcmar, H. 2005. Design, implementation, and evaluation of trust-supporting components in virtual communities for patients. ***Journal of Management Information Systems***, 21(4): 101–135.
Leonardi, P. M. 2010. Digital materiality? How artifacts without matter, matter. ***First Monday***, 15(6).
Leonardi, P. M. 2011. When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies. ***MIS Quarterly***, 35(1): 147–168.
Leonardi, P. M. 2013. The Emergence of Materiality within Formal Organizations. In P. R. Carlile, D. Nicolini, A. Langley, & H. Tsoukas (Eds.), ***How Matter Matters: Objects, Atrifacts and Materiality in Organisation Studies***: 142–170. Oxford: Oxford University Press.
Leonardi, P. M., & Barley, S. R. 2008. Materiality and change: Challenges to building better theory about technology and organizing. ***Information and Organization***, 18(3): 159–176.
Lerner, J., & Tirole, J. 2005. The Scope of Open Source Licensing. ***Journal of Law, Economics, and Organization***, 21(1): 20–56.
Levy, D., & Scully, M. 2007. The Institutional Entrepreneur as Modern Prince: The Strategic Face of Power in Contested Fields. ***Organization Studies***, 28(7): 971–991.
Libert, B., Beck, M., Komar, B., & Estrada, J. 2017. How Technology Can Help Solve Societal Problems. ***Knowledge@Wharton***. http://knowledge.wharton.upenn.edu/article/technology-can-help-solve-societal-problems/. [Accessed November 22, 2017]
Liebeskind, J. P., Oliver, A. L., Zucker, L., & Brewer, M. 1996. Social networks, learning, and flexibility: Sourcing scientific knowledge in new biotechnology firms. ***Organization science***, 7(4): 428–443.
Lin, P.-C. C., & Huang, D.-S. S. 2008. Technological regimes and firm survival: Evidence across sectors and over time. ***Small Business Economics***, 30(2): 175–186.
Lippman, S. A., & Rumelt, R. P. 1982. Uncertain imitability: An analysis of interfirm differences in efficiency under competition. ***The Bell Journal of Economics***, 418–438.
Ljungberg, J. 2000. Open source movements as a model for organising. ***European Journal of Information Systems***, 9(4): 208–216.
Locke, K. 2001. ***Grounded theory in management research***. Sage.
Loh, L., & Venkatraman, N. 1992. Diffusion of information technology outsourcing: influence sources and the Kodak effect. ***Information Systems Research***, 3(4): 334–358.
Lounsbury, M., & Crumley, E. T. 2007. New Practice Creation: An Institutional Perspective on Innovation. ***Organization Studies***, 28(7): 993–1012.

Lounsbury, M., Ventresca, M., & Hirsch, P. M. 2003. Social movements, field frames and industry emergence: a cultural–political perspective on US recycling. ***Socio-Economic Review***, 1(1): 71–104.

Low, M. B., & MacMillan, I. C. 1988. Entrepreneurship: Past research And future challenges. ***Journal Of Management***, 14: 139–161.

Lyytinen, K., & Damsgaard, J. 2011. Inter-organizational information systems adoption - a configuration analysis approach. ***European Journal of Information Systems***, 20(5): 496–509.

Lyytinen, K., & Rose, G. M. 2004. ***Working Papers on Information Systems Explaining Radical Innovation in System Development Organizations***.

Ma, M., & Agarwal, R. 2007. Through a glass darkly: Information technology design, identity verification, and knowledge contribution in Online communities. ***Information Systems Research***, 18(1): 42–67.

MacInnes, I., Moneta, J., Caraballo, J., & Sarni, D. 2002. Business models for mobile content: the case of m-games. ***Electronic Markets***, 12(4): 218–227.

Mair, J., Battilana, J., & Cardenas, J. 2012. Organizing for Society: A Typology of Social Entrepreneuring Models. ***Journal of Business Ethics***, 111(3): 353–373.

Majchrzak, A., & Markus, M. L. 2012. Technology Affordances and Constraints in Management Information Systems (Mis). ***Encyclopedia of Management Theory***.

Malhotra, N. K., Kim, S. S., & Agarwal, J. 2004. Internet users' information privacy concerns: The construct, the scale, and a causal model. ***Information Systems Research***, 15(4): 336–355.

Malone, D., & O'Dwyer, K. J. 2014. Bitcoin Mining and its Energy Footprint. ***Proceedings of 25th IET Irish Signals & Systems Conference 2014 and 2014 China-Ireland International Conference on Information and Communities Technologies (ISSC 2014/CIICT 2014)***: 280–285. Limerick, Ireland.

Mankevich, V., & Holmström, J. 2016. Gateways to Digital Entrepreneurship: Investigating the Organizing Logics for Digital Startups. ***Academy of Management Proceedings***: 13995. Academy of Management.

Markus, M. L., & Keil, M. 1994. If we build it, they will come: Designing information systems that people want to use. ***Sloan Management Review***, 35: 11.

Markus, M. L., Steinfield, C. W., Wigand, R. T., & Minton, G. 2006. Industry-Wide Information Systems Standardisation as Collective Action: The Case of the US Residential Mortage Industry. ***Mis Quarterly***, 30(August): 439–466.

Martens, M. L., Jennings, J. E., & Jennings, P. D. 2007. Do the stories they tell get them the money they need? The role of entrepreneurial narratives in resource acquisition. ***Academy of Management Journal***, 50(5): 1107–1132.

Matlay, H. 2004. E-entrepreneurship and small e-business development: towards a comparative research agenda. ***Journal of Small Business and Enterprise Development***, 11(3): 408–414.

Matlay, H. 2005. Virtual Teams and the Rise of e-Entrepreneurship in Europe. ***International Small Business Journal***, 23(3): 279–302.

Maurer, B., Nelms, T. C., & Swartz, L. 2013. "When perhaps the real problem is money itself!": the practical materiality of Bitcoin. ***Social Semiotics***, 23(2): 261–277.

Mavlanova, T., Benbunan-Fich, R., & Koufaris, M. 2012. Signaling theory and information asymmetry in online commerce. ***Information & Management***, 49(5): 240–247.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. 1995. An integrative model of organizational trust. ***Academy of Management Review***, 20(3): 709–734.

McGarty, T. P. 1992. Alternative networking architectures: Pricing, policy, and competition. ***Building Information Infrastructure.*** McGraw-Hill Primis.

McLure Wasko, M., & Faraj, S. 2000. "It is what one does": why people participate and help

others in electronic communities of practice. ***The Journal of Strategic Information Systems***, 9(2–3): 155–173.

McMillan, R. 2013, June 20. Bitcoin's Big Bank Problem: Why Did Mt. Gox Halt U.S. Payouts? ***Wired US***. http://www.wired.com/2013/06/mt-gox-stops/. [Accessed June 30, 2016]

Meeker, H. J. 2008. ***The open source alternative: understanding risks and leveraging opportunities***. John Wiley & Sons.

Melville, N., Kraemer, K., & Gurbaxani, V. 2004. Review: Information technology and organizational performance: An integrative model of IT business value. ***MIS Quarterly***, 28(2): 283–322.

Meyer, J. W. 2006. Reflections on Institutional Theories of Organizations. ***The Sage Handbook of Organizational Institutionalism***, 788–809.

Meyer, J. W., & Rowan, B. 1977. Institutionalized organizations: Formal structure as myth and ceremony. ***American Journal of Sociology***, 340–363.

Meyer, J. W., & Scott, W. R. 1983. Centralization and the legitimacy problems of local government. ***Organizational environments: Ritual and rationality***, 199–215.

Miles, M. B., & Huberman, A. M. 1994. ***Qualitative data analysis: An expanded sourcebook***. Sage.

Miles, R. E., Miles, G., & Snow, C. C. 2006. Collaborative Entrepreneurship:: A Business Model for Continuous Innovation. ***Organizational Dynamics***, 35(1): 1–11.

Mitchell, R. K., Agle, B. R., & Wood, D. J. 1997. Toward a theory of stakeholder identification and salience: Defining the Principle of Who and What Really Counts. ***Academy of Management Review***, 22(4): 853–886.

Mitchell, R. K., & Cohen, B. 2006. Stakeholder Theory and the Entrepreneurial Firm. ***Journal of Small Business Strategy***, 17: 1–16.

Mol, A., & Law, J. 2002. ***Complexities: An Introduction.*** Duke University Press.

Mollick, E. 2013. The Dynamics of Crowdfunding: Determinants of Success and Failure. ***Journal of Business Venturing***.

Mollick, E. 2014. The Dynamics of Crowdfunding: An Exploratory Study. ***Journal of Business Venturing***, 29(1): 1–16.

Mollick, E., & Nanda, R. 2015. Wisdom or madness? Comparing crowds with expert evaluation in funding the arts. ***Management Science***, 62(6): 1533–1553.

Mollick, E., & Robb, A. 2016. Democratizing Innovation and Capital Access. ***California Management Review***, 58(2): 72–87.

Monteiro, E., Pollock, N., Hanseth, O., & Williams, R. 2013. From artefacts to infrastructures. ***Computer supported cooperative work (CSCW)***, 22(4–6): 575–607.

Moon, J. Y., & Sproull, L. S. 2008. The Role of Feedback in Managing the Internet-Based Volunteer Work Force. ***Information Systems Research***, 19(4): 494–515.

Moran, P. 2005. Structural vs Relational Embeddedness: Social Capital and Managerial Performance. ***Strategic Management Journal Strat. Mgmt. J***, 26: 1129–1151. h

Morisse, M., & Ingram, C. 2016. A mixed blessing: Resilience in the entrepreneurial socio-technical sysetm of Bitcoin. ***Journal of Information Systems and Technology Management***, 13(1).

Mt.Gox. 2014. Announcement Regarding an Application for Commencement of a Procedure of Civil Rehabilitation. https://www.mtgox.com/img/pdf/20140228-announcement_eng.pdf. [Accessed June 30, 2016]

Mueller, M. L. 2010. ***Networks and states: The global politics of Internet governance***. MIT Press.

Muir, B. M., & Moray, N. 1996. Trust in automation. Part II. Experimental studies of trust and human intervention in a process control simulation. ***Ergonomics***, 39(3): 429–460.

Nakamoto, S. 2008. ***Bitcoin: A peer-to-peer electronic cash system***. http://s.kwma.kr/pdf/Bitcoin/bitcoin.pdf. [Accessed June 30, 2016]

Nambisan, S. 2016. Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. ***Entrepreneurship Theory and Practice***. 41(6), 1029-1055.

Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. 2017. Digital Innovation Management: Reinventing Innovation Management Research In A Digital World. ***Mis Quarterly***, 41(1): 223–238.

Nambisan, S., & Sawhney, M. 2011. Orchestration processes in network-centric innovation: Evidence from the field. ***The Academy of Management Perspectives***, 25(3): 40–57.

Nan, N. 2011. Capturing Bottom-up Information Technology Use Processes: A Complex Adaptive Systems Model. ***MIS Quarterly***, 35(2): 505–532.

Nasra, R., & Dacin, M. T. 2010. Institutional arrangements and international entrepreneurship: The state as institutional entrepreneur. ***Entrepreneurship: Theory and Practice***, 34(3): 583–609.

Nee, V., & Ingram, P. 1998. Embeddedness and Beyond: Institutions, Exchange, and Social Structure. ***The New Institutionalism in Sociology***.

Nelson, R. R., & Nelson, R. R. 1995. Recent Evolutionary Tehorizing About Economic Change. ***Journal of Economic Literature***, 33(March): 48–90.

Nonaka, I. 1994. A dynamic theory of organizational knowledge creation. ***Organization Science***, 5(1): 14–37.

North, D., & Smallbone, D. 2006. Developing entrepreneurship and enterprise in Europe's peripheral rural areas: Some issues facing policy-makers. ***European Planning Studies***, 14(1): 41–60.

Nov, O. 2007. What motivates wikipedians? ***Communications of the ACM***, 50(11): 60–64.

Nucciarelli, A., Li, F., Fernandes, K. J., Goumagias, N., Cabras, I., Devlin, S., et al. 2017. From value chains to technological platforms: The effects of crowdfunding in the digital game industry. ***Journal of Business Research***. (forthcoming)

Nyman, L. 2015. ***Understanding Code Forking in Open Source Software***. Hanken School of Economics.

Nyman, L., & Lindman, J. 2013. Code Forking, Governance, and Sustainability in Open Source Software. ***Technology Information Management***, (January): 7–12.

O'Mahony, S. 2003. Guarding the Commons: How Community Managed Software Projects Protect their Work. ***Research Policy***, 32(7): 1179–1198.

O'Mahony, S., & Bechky, B. 2008. Boundary Organizations: Enabling Collaboration among Unexpected Allies. ***Administrative Science Quarterly***.

O'Mahony, S., & Ferraro, F. 2007. The Emergence of a Governance Structure in an Open Source Community. ***Academy of Management Journal***, 50(5): 1079–1106.

Oakes, P. J., Turner, J. C., & Haslam, S. A. 1991. Perceiving people as group members: The role of fit in the salience of social categorizations. ***British Journal of Social Psychology***, 30: 125–144.

Olsen, M., & Boxenbaum, E. 2009. Bottom-of-the-Pyramid: Organizational Barriers to Implementation. ***California Management Review***, 51(4): 100–125.

Orlikowski, W. J. 1992. The Duality of Technology: Rethinking the Concept of Technology in Organizations. ***Organization Science***, 3(3): 398–427.

Orlikowski, W. J. 2007. Sociomaterial Practices: Exploring Technology at Work. ***Organization Studies***, 28(9): 1435–1448.

Orlikowski, W. J. 2010. The sociomateriality of organizational life: considering technology in management research. ***Cambridge Journal of Economics***, 34: 125–141.

Orlikowski, W. J., & Barley, S. R. 2001. Technology and institutions: What can research on information technology and research on organizations learn from each other? ***MIS Quarterly***, 25(2): 145–165.

Orlikowski, W. J., & Iacono, C. S. 2001. Research Commentary: Desperately Seeking the "IT" in IT Research--A Call to Theorizing the IT Artifact. ***Information Systems Research***, 12(2):

121–134.
Orlikowski, W. J., & Robey, D. 1991. Information Technology and the Structuring of Organizations. ***Decision Sciences***, 2(2): 143–170.
Orlikowski, W. J., & Scott, S. V. 2015. The Algorithm and the Crowd: Considering the Materiality of Service Innovation. ***MIS Quarterly***, 39(1).
Osborn, R. N., Hagedoorn, J., Denekamp, J. G., Duysters, G., & Baughn, C. C. 1998. Embedded patterns of international alliance formation. ***Organization Studies***, 19(4): 617–638.
Ostrom, E. 1998. A Behavioral Approach to the Rational Choice Theory of Collective Action: Presidential Address, American Political Science Association 1997. ***American Political Science Association American Political Science Review***, 92(1): 1–22.
Özdemir, V., Faris, J., & Srivastava, S. 2015. Crowdfunding 2.0: the next-generation philanthropy. ***EMBO reports***, 16(3): 267–271.
Padgett, J. F., & Ansell, C. K. 1993. Robust Action and the Rise of the Medici, 1400-1434. ***American journal of sociology***, 98(6): 1259–1319.
Park, J. S. 2005. Opportunity recognition and product innovation in entrepreneurial hi-tech start-ups: A new perspective and supporting case study. ***Technovation***, 25(7): 739–752.
Parker, G. G., & Alstyne, M. W. Van. 2012. Two-Sided Network Information Effects: A Theory of Product Design. ***Management Science***, 51(10): 1494–1504.
Peteraf, M., & Shanley, M. 1997. Getting to know you: A theory of Strategic Group Identity. ***Strategic Management Journal***, 18(Summer Special Issue): 165–186.
Phan, P. H., Wright, M., Ucbasaran, D., & Tan, W.-L. 2009. Corporate entrepreneurship: Current research and future directions. ***Journal of Business Venturing***, 24(3): 197–205.
Phang, C. W., Kankanhalli, A., & Huang, L. 2014. Drivers of Quantity and Quality of Participation in Online Policy Deliberation Forums. ***Journal of Management Information Systems***, 31(3): 172–212.
Phang, C. W., Kankanhalli, A., & Tan, B. C. Y. 2015. What Motivates Contributors vs. Lurkers? An Investigation of Online Feedback Forums. ***Information Systems Research***, 26(4): 773–792.
Pipek, V., & Wulf, V. 2009. Infrastructuring: Toward an Integrated Perspective on the Design and Use of Information Technology. ***Journal of the Association for Information Systems***, 10(May 2009): 447–473.
Pollock, N., & Williams, R. 2010. E-infrastructures: How do we know and understand them? Strategic ethnography and the biography of artefacts. ***Computer Supported Cooperative Work (CSCW)***, 19(6): 521–556.
Popper, N., & Abrams, R. 2014, February 25. Apparent Theft at Mt. Gox Shakes Bitcoin World. ***The New York Times***, B1. http://www.nytimes.com/2014/02/25/business/apparent-theft-at-mt-gox-shakes-bitcoin-world.html?_r=0, New York.
Porter, C. E., & Donthu, N. 2008. Cultivating trust and harvesting value in virtual communities. ***Management Science***, 54(1): 113–128.
Porter, M. 1980. Competitive strategy: Techniques foranalyzing industries and competitors. ***FreePress, New York***.
Porter, M. E. 1998. ***Clusters and the new economics of competition***.
Porter, M. E. 2000. Location, Competition, and Economic Development: Local Clusters in a Global Economy. ***Economic Development Quarterly***, 14(1): 15–34.
Porter, M. E. 2008. Competitive Advantage: Creating and Sustaining Superior Performance. ***Nova***, 592.
Portes, A., & Sensenbrenner, J. 1993. Embeddedness and immigration: Notes on the social determinants of economic action. ***American journal of sociology***, 1320–1350.
Posey, C., Lowry, P. B., Roberts, T. L., & Ellis, T. S. 2010. Proposing the online community self-disclosure model: the case of working professionals in France and the UK who use online communities. ***European Journal of Information Systems***, 19(2): 181–195.

Posner, M. I., & Petersen, S. E. 1989. ***The attention system of the human brain***. DTIC Document.

Post, J. E., Preston, L. E., & Sachs, S. 2002. Managing the extended enterprise: The new stakeholder view. ***California Management Review***, 45(1), 6-28

Powell, E. E., Bingham, C., Clapp, T., Da-, J., Gruber, M., Hambrick, D., et al. 2014. It's What You Make of It: Founder Identity and Enacting Strategic Responses To Adversity. ***Academy of Management Journal***, 57(5): 1406–1433.

Powell, W. W., & Colyvas, J. A. 2008. Microfoundations of institutional theory. ***The Sage handbook of organizational institutionalism***, 276: 298.

Powell, W. W., Di Maggio, P., Meyer, J. W., Rowan, B., Powell, W. W., DiMaggio, P. J., et al. 1991. The New Institutionalism in Organizational Analysis. ***The new institutionalism in organizational analysis***: 486. Chicago: The University of Chicago Press Chicago.

Pratt, M. G., & Foreman, P. O. 2000. Classifying Managerial Responses to Multiple Organizational Identities. ***The Academy of Management Review***, 25(1): 18.

Rai, A., Patnayakuni, R., & Seth, N. 2006. Firm performance impacts of digitally enabled supply chain integration capabilities. ***MIS Quarterly***, 30(2): 225–246.

Rasche, A., & Chia, R. 2009. Researching Strategy Practices: A Genealogical Social Theory Perspective. ***Organization Studies***, 30(7): 713–734.

Raymond, E. 1999. The cathedral and the bazaar. ***Knowledge, Technology & Policy***, 12(3): 23–49.

Reckwitz, a. 2002. Toward a Theory of Social Practices: A Development in Culturalist Theorizing. ***European Journal of Social Theory***, 5(2): 243–263.

Reddit. 2016. Reddit. https://www.reddit.com/, [AccessedJanuary 28, 2016].

Reeves, B., & Nass, C. 1996. ***How people treat computers, television, and new media like real people and places***. CSLI Publications and Cambridge university press.

Reisinger, D. 2015. Google Play gets serious with "expert" screening, age ratings for Android apps. ***CNET***. https://www.cnet.com/uk/news/google-play-adds-app-ratings-to-inform-users-on-content/. [AccessedJanuary 28, 2016].

Ren, Y., Harper, F. M., Drenner, S., Terveen, L., Kiesler, S., Riedl, J., et al. 2012. Building member attachment in online communities: Applying theories of group identity and interpersonal bonds. ***Mis Quarterly***, 36(3): 841–864.

Rentocchini, F., & Rossi-lamastra, C. 2012. Is Open Source Software about Innovation ? Collaborations with the Open Source. ***Journal of Small Business Management***, 50(2): 340–364.

Reuber, A. R., & Fischer, E. 2011. International entrepreneurship in internet-enabled markets. ***Journal of Business Venturing***, 26(6): 660–679.

Rindova, V., Barry, D., & Ketchen, D. J. 2009. Entrepreneuring as emancipation. ***Academy of Management Review***, 34(3): 477–491.

Robey, D., & Boudreau, M. C. 1999. Accounting for the contradictory organizational consequences of information technology: Theoretical directions and methodological implications. ***Information Systems Research***, 10(2): 167–185.

Robles, G., & González-Barahona, J. M. 2012. A comprehensive study of software forks: Dates, reasons and outcomes. ***IFIP International Conference on Open Source Systems***: 1–14. Springer.

Rochet, J.-C., & Tirole, J. 2003. Platform Competition in Two-Sided Markets. ***Journal of the European Economic Association***, 1(4): 990–1029.

Rochet, J.-C., & Tirole, J. 2004. Defining Two-Sided Markets. ***The RAND Journal of Economics***, 1–28.

Rowley, J. 2004. Online branding. ***Online information review***, 28(2): 131–138.

Sandberg, W. R., & Hofer, C. W. 1987. Improving new venture performance: The role of strategy, industry structure, and the entrepreneur. ***Journal of Business Venturing***, 2(1): 5–

28.
Sarasvathy, S. D. 2001. Causation and Effectuatio : A Theoritical Shift From Inevitability to Economic Entrepreneurial Contingency. ***Academy of Management Review***, 26(2): 243–263.
Sarasvathy, S. D. 2004. The questions we ask and the questions we care about: Reformulating some problems in entrepreneurship research. ***Journal of Business Venturing***, 19(5): 707–717.
Sarasvathy, S. D. 2008. ***Effectuation: Elements of Entrepreneurial Expertise***. New York.
Sarasvathy, S. D., & Venkataraman, S. 2011. Entrepreneurship as method: open questions for an entrepreneurial future. ***Entrepreneurship Theory and Practice***, 35(1): 113–135.
Sawhney, H. 1992. The public telephone network: Stages in infrastructure development. ***Telecommunications Policy***, 16(7): 538–552.
Sawhney, M., Verona, G., & Prandelli, E. 2005. Collaborating to create: The Internet as a platform for customer engagement in product innovation. ***Journal of Interactive Marketing***, 19(4): 4–17.
Schatzki, T. R. 2001. Introduction: Practice theory. In T. R. Schatzki, K. K. Cetina, & E. von Savigny (Eds.), ***The practice turn in contemporary theory***: 1–14. London: Routledge.
Schelling, T. 1978. Micromotives and macrobehavior. Nueva York. WW Norton & Company.
Schmidt, D. C., & Porter, A. 2001. Leveraging open-source communities to improve the quality & performance of open-source software. ***Proceedings of the 1st Workshop on Open Source Software Engineering***. Citeseer.
Schumpeter, J. A. 1934. ***The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle***. Harvard : Transaction Publishers.
Scott, W. R. 1995. ***Organizations and institutions***. Thousand Oaks, CA, CA: Sage.
Scott, S. V, & Orlikowski, W. J. 2014. Entanglements in practice: performing anonymity through social media. ***Mis Quarterly***, 38(3): 873–893.
SEC. 2017. SEC Enforcement Actions Addressing Misconduct That Led to or Arose From the Financial Crisis. https://www.sec.gov/spotlight/enf-actions-fc.shtml, [Accessed November 3, 2017].
Seidel, S., Recker, J., & Vom Brocke, J. 2013. Sensemaking and Sustainable Practicing: Functional Affordances of Information Systems in Green Transformations. ***MIS Quarterly***, 37(4): 1275–1299.
Selander, L., & Jarvenpaa, S. L. 2016. Digital action repertoires and transforming a social movement organization. ***MIS Quarterly***, 40(2): 331–352.
Serarols, C. 2008. The process of business start-ups in the internet: a multiple case study. ***International Journal of Technology Management***, 43(1/2/3): 142.
Shaikh, M., & Cornford, T. 2003. Version control software for knowledge sharing, innovation and learning in OS. ***Open Source Software Movements and Communities Workshop hosted by the International Conference on Communities and Technologies, Amsterdam, The Netherlands***.
Shane, S. 2000. Prior Knowledge and the Discovery of Entrepreneurial Opportunities. ***Organization Science***, 11(4): 448–469.
Sharma, P., & Chrisman, S. J. J. 1999. Toward a reconciliation of the definitional issues in the field of corporate entrepreneurship*. ***Entrepreneurship Theory and Practice***, 23: 11–27.
Sherman, N. 2017, June 9. Are Google, Amazon and others getting too big? ***BBC News***. http://www.bbc.com/news/business-39875417. [Accessed November 3, 2017].
Shiller, R. J. 2012. ***The subprime solution: how today's global financial crisis happened, and what to do about it***. Princeton University Press.
Sievert, C., & Shirley, K. 2014. LDAvis: A method for visualizing and interpreting topics. ***Proceedings of the Workshop on Interactive Language Learning, Visualization, and Interfaces***: 63–70.

Siggelkow, N. 2007. Persuasion with case studies. ***Academy of Management Journal***, 50(1): 20–24.

Simon, G., von Krogh, G., Leonard, D., & Swap, W. W. 2004. Resource allocation beyond firm boundaries: A multi-level model for open source innovation. ***Long Range Planning***, 37(6): 591–610.

Simon, H. A. 1982. ***Models of Bounded Rationality: Empirically grounded economic reason***. MIT Press.

Simsek, Z., Lubatkin, M. H., & Floyd, S. W. 2003. Inter-Firm Networks and Entrepreneurial Behavior: A Structural Embeddedness Perspective. ***Journal of Management***, 29(3): 427–442.

Sine, W. D., & David, R. J. 2003. Environmental jolts, institutional change, and the creation of entrepreneurial opportunity in the US electric power industry. ***Research Policy***, 32(2): 185–207.

Sine, W. D., Mitsuhashi, H., & Kirsch, D. a. 2006. Revisiting burns and stalker: Formal structure and new venture performance in emerging economic sectors. ***Academy of Management Journal***, 49(1): 121–132.

Smets, M., Morris, T., & Greenwood, R. 2012. From practice to field: A multilevel model of practice-driven institutional change. ***Academy of Management Journal***, 55(4): 877–904.

Soh, C., & Sia, S. K. 2004. An institutional perspective on sources of ERP package–organisation misalignments. ***The Journal of Strategic Information Systems***, 13(4): 375–397.

Sonenshein, S., Nault, K., & Obodaru, O. 2017. Competition of a Different Flavor: How a Strategic Group Identity Shapes Competition and Cooperation. ***Administrative Science Quarterly***, (Forthcoming)

Sørensen, C., & Gibson, D. 2004. Ubiquitous visions and opaque realities: professionals talking about mobile technologies. ***INFO – The Journal of Policy, Regulation and Strategy for Telecommunication, Information and Media***, 6(3): 188–196.

Southurst, J. 2014. ***Mt. Gox Halts ALL Bitcoin Withdrawals, Price Drop Follows***. http://www.coindesk.com/mt-gox-halts-bitcoin-withdrawals-price-drop/. [Accessed June 30, 2016]

Sowe, S. K., Stamelos, I., & Angelis, L. 2008. Understanding knowledge sharing activities in free/open source software projects: An empirical study. ***Journal of Systems and Software***, 81(3): 431–446.

Spaeth, S., Stuermer, M., & Krogh, G. Von. 2010. Enabling knowledge creation through outsiders: towards a push model of open innovation. ***International Journal of Technology Management***, 52: 411.

Spaven, E. 2013. ***Mt. Gox enhances site performance by partnering with cloud platform Akamai***. http://www.coindesk.com/mt-gox-improves-site-performance-by-partnering-with-cloud-platform-akamai/. [Accessed June 30, 2016]

Spence, P. 2015, February 25. Bitcoin revolution could be the next internet, says Bank of England. ***The Telegraph***. [Accessed June 30, 2016]

Star, S. L. 1999. The Ethnography of Infrastructure. ***American Behavioral Scientist***, 43(3): 377–391.

Star, S. L., & Ruhleder, K. 1996. Steps toward an ecology of infrastructure: Design and access for large information spaces. ***Information Systems Research***, 7(1): 111–134.

Stemler, A. R. 2013. The JOBS Act and crowdfunding: Harnessing the power—and money—of the masses. ***Business Horizons***, 56(3): 271–275.

Stewart, K. J., & Gosain, S. 2006. The Impact of Ideology on Effectiveness in Open Source Software Development Teams. ***MIS Quarterly***, 30(2): 1–5.

Steyaert, C. 2007. "Entrepreneuring" as a conceptual attractor? A review of process theories in 20 years of entrepreneurship studies. ***Entrepreneurship & Regional Development***, 19(November): 453–477.

Steyaert, C., & Katz, J. 2004. Reclaiming the space of entrepreneurship in society: geographical, discursive and social dimensions. ***Entrepreneurship & Regional Development***, 16(May): 179–196.

Stokes, R. 2012. Virtual money laundering: the case of Bitcoin and the Linden dollar. ***Information & Communications Technology Law***, 21(3): 221–236.

Stringfellow, L., Shaw, E., & Maclean, M. 2013. Apostasy versus legitimacy: Relational dynamics and routes to resource acquisition in entrepreneurial ventures. ***International Small Business Journal***, 32(5): 571–592.

Strong, D. M., Johnson, S. A., Tulu, B., Trudel, J., Volkoff, O., Pelletier, L. R., et al. 2014. A Theory of Organization-EHR Affordance Actualization. ***Journal of the Association for Information Systems***, 15(2): 53–85.

Suchman, M. C. 1995. Managing legitimacy: Strategic and institutional approaches. ***Academy of Management Review***, 20(3): 571–610.

Suddaby, R. 2006. From the editors: What grounded theory is not. ***Academy of management journal***, 49(4): 633–642.

Suddaby, R. 2010. Challenges for Institutional Theory. ***Journal of Management Inquiry***, 19(1): 14–20.

Suddaby, R., & Greenwood, R. 2005. Rhetorical Strategies of Legitimacy. ***Administrative Science Quarterly***, 50: 35–67.

Sutton, R. I., & Callahan, A. L. 1987. The stigma of bankruptcy: Spoiled organizational image and its management. ***Academy of Management journal***, 30(3): 405–436.

Svahn, F., Mathiassen, L., & Lindgren, R. 2017. Embracing Digital Innovation in Incumbent Firms: How Volvo Cars Managed Competing Concerns. ***Mis Quarterly***, 41(1): 239–253.

Swanson, E. B., & Ramiller, N. C. 2004. Innovating mindfully with information technology. ***MIS Quarterly***, 28(4): 553–583.

Swedberg, R. 1997. New economic sociology: What has been accomplished, what is ahead? ***Acta Sociologica***, 40(2): 161–182.

Sztompka, P. 1999. ***Trust: A sociological theory***. Cambridge University Press.

Szulanski, G. 1996. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. ***Strategic Management Journal***, 17(S2): 27–43.

Tajfel, H., & Turner, J. C. 1979. An integrative theory of intergroup conflict. ***The social psychology of intergroup relations***, 33(47): 74.

Tanriverdi, H., Konana, P., & Ge, L. 2007. The choice of sourcing mechanisms for business processes. ***Information Systems Research***, 18(3): 280–299.

Taylor, M. B. 2013. Bitcoin and The Age of Bespoke Silicon How Bitcoin Works : User Perspective Bitcoin Mining : Miner's Perspective. ***Proceedings of 2013 International Conference on Compilers, Architecture and Synthesis for Embedded Systems (CASES)***: 1–10. Montreal, Canada.

The Troubling Holes in MtGox's Account of How It Lost $ 600 Million in Bitcoins. 2014, April. ***MIT Technology Review***, (April 2014): 1–3. http://www.technologyreview.com/view/526161/the-troubling-holes-in-mtgoxs-account-of-how-it-lost-600-million-in-bitcoins/. [Accessed June 30, 2016]

Thielman, S. 2016. Facebook fires trending team, and algorithm without humans goes crazy. https://www.theguardian.com/technology/2016/aug/29/facebook-fires-trending-topics-team-algorithm [Accessed November 2, 2017]

Thorne, L., & Saunders, S. B. 2002. The socio-cultural embeddedness of individuals' ethical reasoning in organizations (cross-cultural ethics). ***Journal of Business Ethics***, 35(1): 1–14.

Thornton, P. H., Ribeiro-Soriano, D., & Urbano, D. 2011. Socio-cultural factors and entrepreneurial activity: An overview. ***International Small Business Journal***, 25(2): 105–118.

Tilson, D., Lyytinen, K., & Sørensen, C. 2010. Digital infrastructures: The missing IS research

agenda. ***Information Systems Research***, 21(4): 748–759.

Tilson, D., Sorensen, C., & Lyytinen, K. 2012. Change and Control Paradoxes in Mobile Infrastructure Innovation. ***45th Hawaii International Conference on System Science (HICSS)***: 1324–1333.

Tiwana, A., Konsynski, B., & Bush, A. a. 2010. Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. ***Information Systems Research***, 21(4): 675–687.

Tjosvold, D. 1984. Cooperation theory and organizations. ***Human Relations***, 37(9): 743–767.

Tornikoski, E. T., & Newbert, S. L. 2007. Exploring the determinants of organizational emergence: A legitimacy perspective. ***Journal of Business Venturing***, 22(2): 311–335.

Toyama, K. 2015. ***Geek heresy: Rescuing social change from the cult of technology***. PublicAffairs.

Tracey, P., & Phillips, N. 2015. Managing the Consequences of Organizational Stigmatization: Identity Work in a Social Enterprise. ***Academy of Management Journal***, 59(3): 740–765.

Trice, H. M., & Beyer, J. M. 1993. ***The cultures of work organizations***. JSTOR.

Tufekci, Z. 2014. Social movements and governments in the digital age: Evaluating a complex landscape. ***Journal of International Affairs***, 68(1): 1.

Tufekci, Z., & Wilson, C. 2012. Social media and the decision to participate in political protest: Observations from Tahrir Square. ***Journal of Communication***, 62(2): 363–379.

Tumbas, S., Seidel, S., Berente, N., & Brocke, J. 2015. The " Digital Façade " of Rapidly Growing Entrepreneurial Organizations. ***Proceedings of the 36th International Conference on Information Systems (ICIS)***, (July 2016): 1–19.

Urquhart, C. 2012. ***Grounded theory for qualitative research: A practical guide***. Sage.

Uzzi, B. 1996. The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect. ***American Sociological Review***.

Uzzi, B. 1997. Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness. ***Administrative Science Quarterly***.

Uzzi, B. 1999. Embeddedness in the Making of Financial Capital: How Social Relations and Networks Benefit Firms Seeking Financing. ***American Sociological Review***, 64(4): 481.

Uzzi, B., & Lancaster, R. 2003. Relational Embeddedness and Learning: The Case of Bank Loan Managers and Their Clients. ***Management Science***, 49(April 2014): 383–399.

Vaast, E., & Walsham, G. 2009. Trans-situated learning: supporting a network of practice with an information infrastructure. ***Information Systems Research***, 20(4): 547–564.

Van de Ven, H. 1993. The development of an infrastructure for entrepreneurship. ***Journal of Business venturing***, 8(3): 211–230.

van Dijk, S., Berends, H., Jelinek, M., Romme, a. G. L., & Weggeman, M. 2011. Micro-Institutional Affordances and Strategies of Radical Innovation. ***Organization Studies***, 32(11): 1485–1513.

Van Dijk, T. A. 1995. Ideological discourse analysis. ***New Courant***, 4(1): 135–161.

van Lente, H. 2012. Navigating foresight in a sea of expectations: lessons from the sociology of expectations. ***Technology Analysis & Strategic Management***, 24(8): 769–782.

Van Praag, C. M., & Versloot, P. H. 2007. What is the value of entrepreneurship? A review of recent research. ***Small Business Economics***, 29(4): 351–382.

Vance, A., Elie-Dit-Cosaque, C., & Straub, D. W. 2008. Examining Trust in Information Technology Artifacts: The Effects of System Quality and Culture. ***Journal of Management Information Systems***, 24(4): 73–100.

Venkataraman, S. 1997. The distinctive domain of entrepreneurship research. ***Advances in entrepreneurship, firm emergence and growth***, 3(1): 119–138.

Venkatesh, V., Brown, S. a., & Bala, H. 2013. Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in Information Systems. ***Management Information Systems Quarterly***, 37(3): 855–879.

Vergne, J.-P. 2012. Stigmatized categories and public disapproval of organizations: A mixed-methods study of the global arms industry, 1996–2007. ***Academy of Management Journal***, 55(5): 1027–1052.

Vesper, K. H. 1984. ***Three faces of corporate entrepreneurship: A pilot study***. University of Washington. Graduate School of Business.

Vigna, P. 2014, February 25. 5 Things About Mt. Gox's Crisis. ***The Wall Street Journal***. http://blogs.wsj.com/briefly/2014/02/25/5-things-about-mt-goxs-crisis/, New York. [Accessed June 30, 2016]

Volkoff, O., & Strong, D. 2013. Critical realism and affordances: theorizing IT-associated organizational change processes. ***Mis Quarterly***, 37(3): 819–834.

Von Krogh, G., & Haefliger, S. 2010. Opening up design science: The challenge of designing for reuse and joint development. ***Journal of Strategic Information Systems***, 19(4): 232–241.

von Krogh, G., & Spaeth, S. 2007. The open source software phenomenon: Characteristics that promote research. ***Journal of Strategic Information Systems***, 16(3): 236–253.

von Krogh, G., Spaeth, S., & Lakhani, K. R. 2003. Community, joining, and specialization in open source software innovation: A case study. ***Research Policy***, 32(7): 1217–1241.

Wallin, M. W., & Von Krogh, G. 2010. Organizing for open innovation: Focus on the integration of knowledge. ***Organizational Dynamics***, 39(2): 145–154.

Wang, P. 2010. Chasing the hottest IT: Effests of information technology fashion on organisations. ***Mis Quarterly***, 34(1): 63–85.

Ward, C., & Ramachandran, V. 2010. Crowdfunding the next hit : Microfunding online experience goods. ***University of Massachusetts Working Paper***, 1–5.

Wasko, M. M., & Faraj, S. 2005. Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. ***MIS Quarterly***, 29(1): 35–57.

Wasko, M. M., Teigland, R., & Faraj, S. 2009. The provision of online public goods: Examining social structure in an electronic network of practice. ***Decision Support Systems***, 47(3): 254–265.

Webb, J. W., Tihanyi, L., Ireland, R. D., & Sirmon, D. G. 2009. You say illegal, I say legitimate: Entrepreneurship in the informal economy. ***Academy of Management Review***, 34(3): 492–510.

Weber, M. 1978. ***Economy and society: An outline of interpretive sociology***. Univ of California Press.

Weber, S. 2004. ***The success of open source***. Cambridge Univ Press.

Weick, K. E. 1995. ***Sensemaking in organizations***. Sage.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. 2005. Organizing and the Process of Sensemaking. ***Organization Science***, 16(4): 409–421.

Welch, C., & Wilkinson, I. 2004. The political embeddedness of international business networks. ***International marketing review***, 21(2): 216–231.

Wenger, E. 2000. Communities of Practice and Social Learning Systems. ***Organization***, 7(2): 225–246.

Wheat, R. E., Wang, Y., Byrnes, J. E., & Ranganathan, J. 2013. Raising money for scientific research through crowdfunding. ***Trends in ecology & evolution***, 28(2): 71–72.

Wheelwright, S. C., & Clark, K. B. 1992. ***Revolutionizing product development: quantum leaps in speed, efficiency, and quality***. Simon and Schuster.

Whittington, R. 2006. Completing the Practice Turn in Strategy Research. ***Organization Studies***, 27(5): 613–634.

Wilkinson, J. 2007. Fair trade: Dynamic and dilemmas of a market oriented global social movement. ***Journal of Consumer Policy***, 30(3): 219–239.

Witt, P. 2004. Entrepreneurs' networks and the success of start-ups. ***Entrepreneurship & Regional Development***, 16(5): 391–412.

Wright, A. L., & Zammuto, R. F. 2013. Wielding the willow: Processes of institutional change in

english county Cricket. ***Academy of Management Journal***, 56(1): 308–330.

Wu, J. H., & Wang, S. C. 2005. What drives mobile commerce? An empirical evaluation of the revised technology acceptance model. ***Information and Management***, 42(5): 719–729.

Wu, J., & Olk, P. 2014. Technological advantage, alliances with customers, local knowledge and competitor identification. ***Journal of Business Research***, 67(10): 2106–2114.

Yakhlef, A. 2010. The corporeality of practice-based learning. ***Organization Studies***, 31(4): 409–430.

Yan, L., Peng, J., & Tan, Y. 2015. Network Dynamics: How Can We Find Patients Like Us? ***Information Systems Research***, 26(3): 496–512.

Yelowitz, A., & Wilson, M. 2015. Characteristics of Bitcoin users: an analysis of Google search data. ***Applied Economics Letters***, 22(13): 1–7.

Yermack, D. 2013. ***Is Bitcoin a Real Currency?*** National Bureau of Economic Research.

Yetis-Larsson, Z., Teigland, R., & Dovbysh, O. 2015. Networked Entrepreneurs: How Entrepreneurs Leverage Open Source Software Communities. ***American Behavioral Scientist***, 59(4): 475–491.

Yin, R. 2003. ***Applications of Case Study Research (Applied Social Research Methods)*** (4th editio.). Thousand Oaks: Sage.

Yin, R. K. 1981. The Case Study Crisis: Some Answers. ***Administrative Science Quarterly***, 26(1): 58–65.

Yin, R. K. 2009. ***Case Study Research: Design and Methods***. (L. Bickman & D. J. Rog, Eds.)***Essential guide to qualitative methods in organizational research***. Sage Publications.

Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, A. 2012. Organizing for Innovation in the Digitized World. ***Organization Science***, 23(5): 13–32.

Yoo, Y., Henfridsson, O., & Lyytinen, K. 2010. The new organizing logic of digital innovation: An agenda for information systems research. ***Information Systems Research***, 21(4): 724–735.

Yoo, Y., Lyytinen, K., & Boland Jr., R. J. 2008. Distributed Innovation in Classes of Networks. ***Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)***: 58–58. IEEE.

Yoo, Y., Lyytinen, K., & Yang, H. 2005. The role of standards in innovation and diffusion of broadband mobile services: The case of South Korea. ***Journal of Strategic Information Systems***, 14(3): 323–353.

Younkin, P., & Kashkooli, K. 2016. What problems does crowdfunding solve? ***California Management Review***, 58(2): 20–43.

Zahra, S. A., & Covin, J. G. 1995. Contextual influences on the corporate entrepreneurship-performance relationship: A longitudinal analysis. ***Journal of Business Venturing***, 10(1): 43–58.

Zahra, S. A., Gedajlovic, E., Neubaum, D. O., & Shulman, J. M. 2009. A typology of social entrepreneurs: Motives, search processes and ethical challenges. ***Journal of Business Venturing***, 24(5): 519–532.

Zaltman, G., Duncan, R., & Holbek, J. 1973. ***Innovations and organizations***. John Wiley & Sons.

Zammuto, R. F., Griffith, T. L., Majchrzak, a., Dougherty, D. J., & Faraj, S. 2007. Information Technology and the Changing Fabric of Organization. ***Organization Science***, 18(5): 749–762.

Zhao, F., Barratt-Pugh, L., Standen, P., Suseno, Y., & Redmond, J. 2017. Digital Entrepreneurship–A Social Interaction Perspective. ***Academy of Management Proceedings***: 12745. Academy of Management.

Zhao, S., Grasmuck, S., & Martin, J. 2008. Identity construction on Facebook: Digital empowerment in anchored relationships. ***Computers in Human Behavior***, 24(5): 1816–

1836.
Zimmer, C., & Emlen, D. J. 2013. ***Evolution: Making sense of life***. Roberts Greenwood Village, CO.
Zimmerman, M. A., & Zeitz, G. J. 2002. Beyond survival: Achieving new venture growth by building legitimacy. ***Academy of Management Review***, 27(3): 414–431.
Zirpoli, F., & Becker, M. C. 2008. Organizing complex product development: outsourcing, performance integration and the role of product architecture. ***Performance Integration and the Role of Product Architecture (January 25, 2008)***.
Zittrain, J. L. 2006. The Generative Internet. ***Harvard Law Review***, 119: 1974–2040.
Zott, C., & Huy, Q. N. 2007. How Entrepreneurs Use Symbolic Management to Acquire Resources. ***Administrative Science Quarterly***, 52(1): 70–105.
Zukin, S., & DiMaggio, P. J. 1990. Structure of capital. ***Cambridge, UK: Cambridge University Press***, 1(3): 5.
Zvilichovsky, D., Inbar, Y., & Barzilay, O. 2013. Playing Both Sides of the Market: Success and Reciprocity on Crowdfunding Platforms. ***SSRN Library***.

Appendices

Appendix One

Table 18: The five events that culminated in Mt.Gox declaring bankruptcy

	Description	**Date**
Event 1	Mt.Gox suspended trading from to "cool down the market". The price of a Bitcoin fell from 266 USD to 56 USD and stabilised above 100 USD after the resumption of trading (Buterin, 2013).	11-12 April 2013
Event 2	The exchange suspended withdrawals of customer funds due to self-claimed "system improvements" and problems with their banking partners (McMillan, 2013).	20 June 2013
Event 3	Ongoing problems with banks blamed for withdrawal lags in a Mt.Gox press release (Spaven, 2013)	5 August 2013
Event 4	Mt.Gox halted all withdrawals of customer funds to investigate technical problems at the exchange. Shortly thereafter, Mt.Gox publicly blamed "transaction malleability", a technical flaw in the Bitcoin protocol, for the problems (Southurst, 2014)	7 February 2014.
Event 5	Mt.Gox filed for bankruptcy after the exchange website went offline 4 days earlier (Mt.Gox, 2014)ry 2014	28 February 2014

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Appendix Two

Table 19: Summary of the ideological positions of the Bitcoin entrepreneurs interviewed

Ideology	Beliefs, values, and norms	Interpretation of Stigma	Illustrative quotations
Mainstream	Beliefs: Believed that stigma in the Bitcoin community stemmed from fraud and illegal behaviours; and that success as an entrepreneur required collaboration with authorities, even if doing so meant more centralisation. Believed that Bitcoin could change finance but that this was not a given. Values: Aimed for collaboration with authorities and existing actors, called for clearer regulation of the Bitcoin space. Norms: Collaboration with authorities, partnerships with banks. Focus on integrating Bitcoin with existing financial solutions, will insure/underwrite Bitcoins.	Non-professionalism and libertarian statements by the OS Community are thought to have led to stigma. These prevented entrepreneurs from building trust with authorities and limit the potential customer base.	*And as long as you stay and have, essentially, obey the law in the jurisdictions you're working in, I think you're out of risk. And that's our policy on that one. But I think in the community there's a tendency to want to run a huge risk in the area* (Firm H).
Pragmatist	Beliefs: Believed that although the Bitcoin community had stigma, users were seldom painted with the same brush. Believed that Bitcoin's dominance was inevitable and regulators and banks needed to adapt or die. Values: Willing to cooperate with external actors for the purposes of legitimacy building and for customers' piece of mind but mainstream buy-in is unnecessary for Bitcoin's success. Norms: Believe that the market will govern prices and adoption of Bitcoin. Focus on customer service and demonstrating Bitcoin's uses, and will insure customers' Bitcoins.	Pragmatic entrepreneurs have limited interest in source of the stigma. Instead, they see a need to build a critical mass of supporters in order to normalise Bitcoin use, and thus overcome stigma.	*The trust that people have in the Bitcoin ecosystem is reflected in the Bitcoin price. If the trust is high, the Bitcoin price goes up.* (Firm G) *I think the crucial year was 2013 where the bad apples had been removed with Mt.Gox and since then there is a huge professionalization of the market.* (Firm I)
Technologist	Beliefs: The technology underlying Bitcoin, including the use of cryptography and transparency, make it secure. It is important as a use-case and its broader adoption is largely irrelevant. Values: Willing to cooperate with researchers and research institutes but	The stigma is seen to stem from a misunderstanding of the technology. Improved understanding of the tech-	*Bitcoin is not going anywhere and it is, the ecosystem is very decentralized and there so many services around that, always the people who are willing*

	uninterested in governments. Norms: Opt-in from regulators and others is irrelevant to its success. Any success it has will be due to its design. Focus on technical features of Bitcoin.	nology, and its wider use, will therefore overcome the stigma.	*to invest at least some... it is quite clear to me that Bitcoin will only move forward.* (Firm J)
Libertarian	Beliefs: Governments have incentives to be corrupt and inefficient, as well as meddle with market forces. Bitcoin will survive and thrive no matter what therefore failure to cooperate with authorities gives legitimacy. Values: Bitcoin should remain independent of governments in order to prevent meddling and corruption. Trusts other members of the Bitcoin community over external actors. Norms: Independence from the state and external actors, unwilling to disclose client information. Sees personal responsibility as pivotal.	Mainstream actors like banks and governmental agencies are seen as the source of the stigma: They are thought to undermine Bitcoin because it threatens them.	*[Bitcoin] is fast, it is secure, it works everywhere in the world, it does not tell you either you can transfer or not. It doesn't exclude you if you live in a poor country or in some kind of danger zone. [Unlike] banks who do not open a branch in danger zone, or in Africa or somewhere, Bitcoin does not make any excludes, it just works everywhere.* (Firm B)

Appendix Three

Table 20: Entrepreneurs' ideological leanings and business models

Firm	Ideology	Business Model				Illustrative quotations
		Service	Customer interaction	Community Involvement	Engagement with banks/regulators	
A	Technologist	Peer-to-peer lending platform	Indirect 2-sided marketplace	Reliant but limited involvement	"Wait and see" approach	*Most of the users come from English speaking countries. So those were the people, who I am very sure just came from the Bitcoin community who are simply interested in the kind of services many startups provide based on Bitcoin.*
B	Technologist	Consulting services and hardware reseller	Direct sales	Actively involved	"Wait and see" approach	*We are a kind of a community creator. We make Bitcoin meetings, and conferences so if somebody wants to get to know cryptocurrency or digital currency better I think it is good idea to contact us.*
C	Mainstream	Peer-to-peer exchange platform, wallet service	Indirect 2-sided marketplace	Reliant but avoids endorsing community	Active cooperation	*Users pay the price of the bought bitcoins always directly to the seller, so to the banking account of the seller, so that [Firm name] never receives or transfer client funds.*
D	Technologist	Startup incubator and consulting services	Direct sales	Reliant but limited involvement	"Wait and see" approach	*When [Firm name] was created, it was a small community of Bitcoin. So the creation of trust was creating a solid website with good service where people can contact us, know we are real people and not trying to scam them. We started by just creating [a] website and offering [a] service and few people tried it out and the reviews came online after that. Then it grew from there so we are relying on Bitcoin community, which is a very strong community, to vouch for us.*
E	Libertarian	Direct-to-customer	Direct sales	Actively involved	Avoided interaction	(And has there been demand for you to hold [Bitcoins] for them [customers]?) *Some but not that much actually. Most want to hold them-*

		exchange platform				*selves because that's safer. That's kind of the idea with Bitcoin, like be your own bank and all that.*
F	Technologist	Technical consulting service	Direct sales	Reliant but limited involvement	Avoided interaction	(Do you collaborate with banks or regulators?) *Not currently. We hope that for the future. By now, this would be a waste of time to contact them; we need to get into a position where we can negotiate with the government first.*
G	Pragmatist	Hardware retailer and cloud service provider	Direct sales	Indifferent to community	Indifferent to external actors	*The market shifted a bit: from home miners… and now we have come to a point where it is not really profitable, with the Bitcoin price down, and all of the investments going in, it's no more profitable to mine at a small scale. You need these industrial settings – cheap electricity. So now we stopped selling to end users and we are continuing to develop the next generation [of hardware].*
H	Pragmatist	Retail exchange platform	Direct sales	Reliant but avoids endorsing community	Selective cooperation	*We want to have a deal with an operator, have a deal with a bank, we wanted to have licences in all of the jurisdictions that we operate, so we essentially are tied in as an integral part of the existing financial services in the society and by that better be able to do the migration from the existing services to something that might come in the future, based on digital currencies.*
I	Mainstream	Direct-to-customer exchange platform	Direct sales	Reliant but avoids endorsing community	Active cooperation	*We believe there will be a point where people will not have to switch back to Fiat currency, and we believe at that point we can activate on a business model side.* *Our role is it to make it as simple easy and user friendly as possible. When you look at the global market we are probably at the forefront to make it as user friendly as possible. Now we are in the testing phase. We are making it more and more accessible for the average consumer.*
J	Libertarian	Peer-to-peer exchange platform	Indirect 2-sided marketplace	Actively involved	Avoided interaction	*I have been somewhat active in the community for some time, so people knew me always as a public person, I did not hide my identity, so that is why people trusted us in the beginning. I also organized some Bitcoin hackathons and so on.*

Appendix Four

Table 21:Coding of entrepreneurs' responses to stigma

Open Coding	Axial Coding	Selective Coding
Do not cooperate with governmental agencies and do not disclose account information	Refuse to cooperate with mainstream	Isolation
Existing banking infrastructure antiquated and bureaucratic		
Large organizations in Bitcoin should be avoided as this can lead to another Mt.Gox	Refuse to collaborate with OS community	
Wants to limit influence of Bitcoin foundation	Boundary from OS community	
Avoid buying and selling with known libertarians		
Position themselves as countermovement to Mt.Gox to attract customer	Boundary from contaminated firm	
Distance themselves from Mt.Gox users, calling them arbitrage traders		
Claims to be the most respected enterprise in the Bitcoin environment	Elevate own status within Bitcoin community	Elevation
Consider themselves local market leaders	Elevate own status within Mainstream community	
Strengthen their partnership with banking partner	Cooperate with mainstream	Association
Establish relationships with banks and governmental agencies by		
Transparent about entrepreneurship and operations helped gain trust		
Over-complying with regulations		
Blocked American customers because existing regulations		
Regulators move with caution and prevents provoking them		
Entrepreneur is active in the community, helped establish trust	Collaborate with OS community	
Emphasize technical openness and transparency towards community		
Building up transparency of own processes and infrastructure via documentation and blogs		
Sponsored a Bitcoin trading tour to support adoption of Bitcoin trading		

Open Coding	Axial Coding	Selective Coding
Organizes community events and conferences		
Checks reliability of partners or customers	Collaborate with screened partners (no ideological pref)	
Revaluation of own infrastructure and processes to reassure	Internal controls (operational)	Verification
Changed procedures to eliminate all thinkable possibilities;		
Trying to build up a robust system customer can use for their services		
Emphasize flexibility as environment is volatile and future developments cannot be foreseen		
Compensate customers for losses		
Hired additional personnel that can handle the technical system		
Building up technical redundancy, extra servers and capacity	Internal controls (technical)	
Implemented a CRM system after problems occurred after an order peak		
Has built up a well-structured and clear website	Public awareness (technical)	Indemnification
Ensure information on website		
Using an online forum for interested users to build up trust and transparency of actions		
Refuses to store Bitcoins of customers	Avoid responsibility for losses	
Emphasize holding Bitcoin in own wallets		
Holding Bitcoins removed customer autonomy		
Storage of Bitcoin at exchanges would contradict Bitcoin idea		
Checks conducted at banking partner	External controls	
Introduced service (wallets) outside their core business model		
Cryptographic audit		

Appendix Five

Figure 14: Screenshot of crowdfunding platform