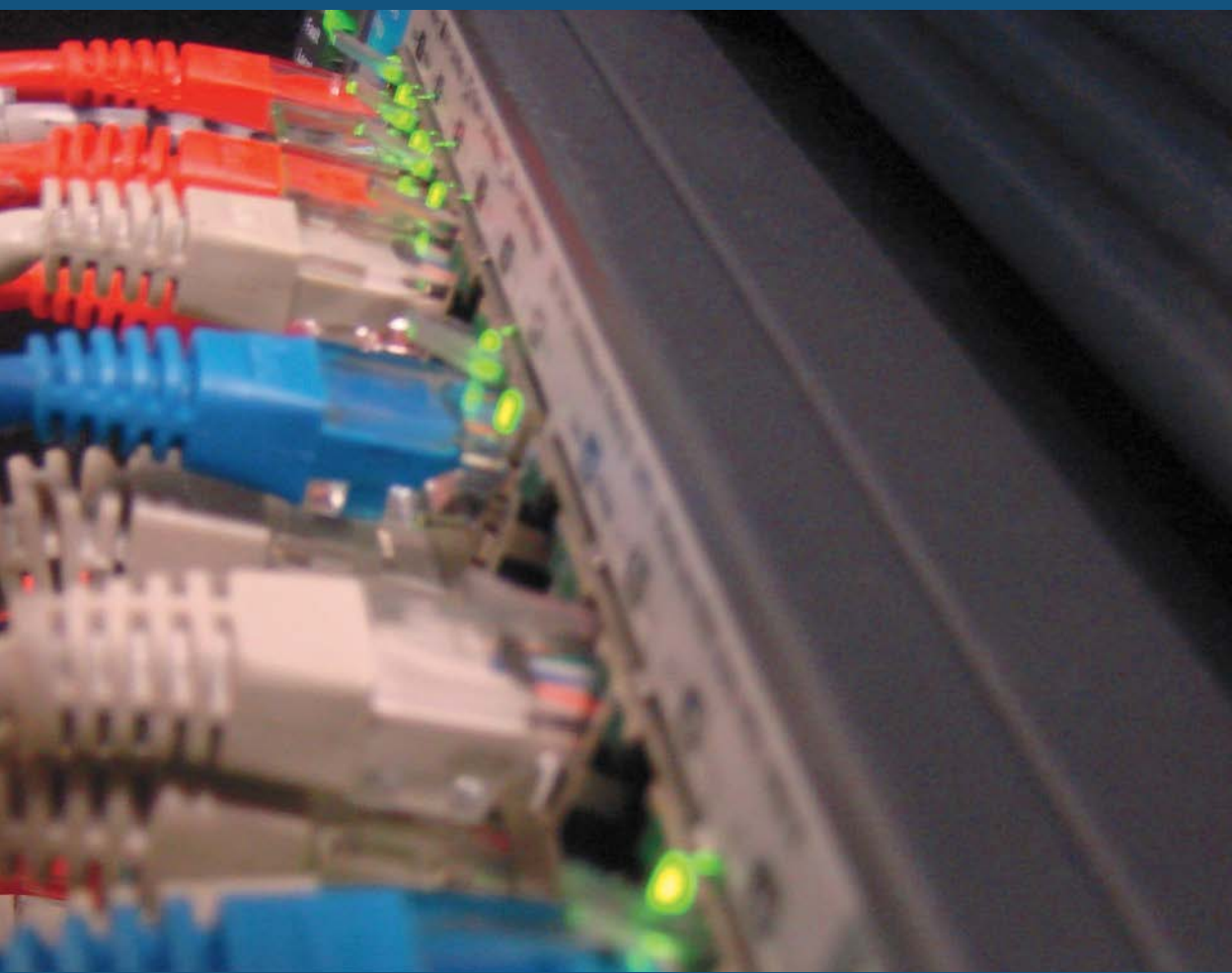
Crowds, Coins and Communities

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.

To Anna Felländer, Rachael Dixon, Malin Holm, Adrian Glinqvist, Äke Freij, and others, thank you for the lunches and *fikas* outside of the ivory tower.

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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

Contents

List of Tables

List of Figures

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?

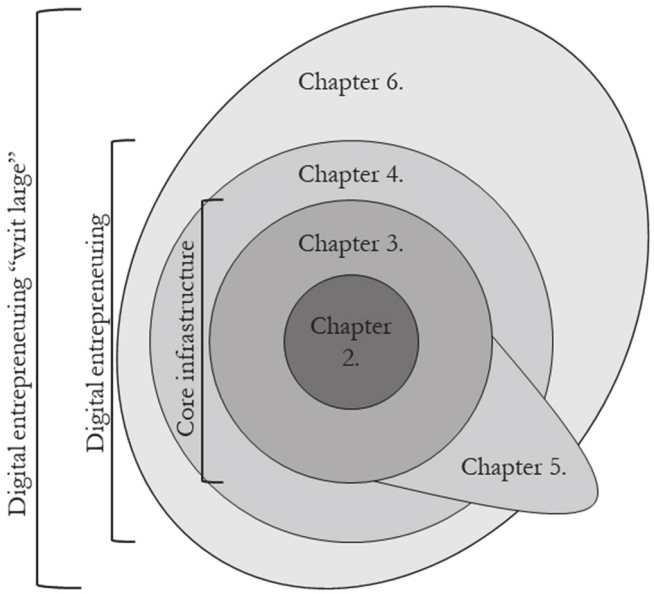
We found that digital infrastructures mediate in such a social movement, and develop an understanding and vocabulary to talk about a digital economic social movement. Code, which is the substrate of such a movement, consequently leads to a) a novel form of collective (in)action; b) new frames for meaning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

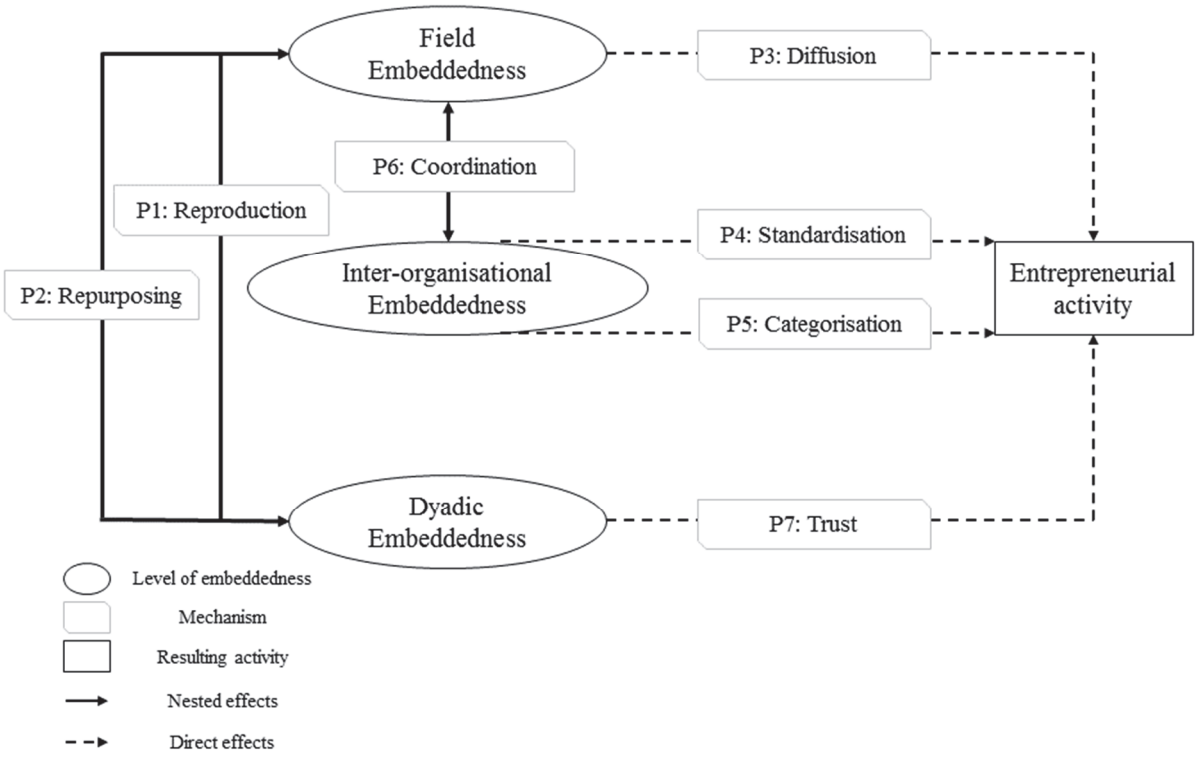
Chapter 2 identifies three different technical changes to the underlying infrastructure, and the implications that they have for organising through an empirical examination of the Bitcoin OS community. First, *hard forks;* they lead directly to new organisational outcomes though *speciation*, and rely 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.

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