

A MIXED BLESSING: RESILIENCE IN THE ENTREPRENEURIAL SOCIO-TECHNICAL SYSTEM OF BITCOIN

Marcel Morisse

University of Hamburg, Hamburg, Germany

Claire Ingram

Stockholm School of Economics, Stockholm, Sweden

ABSTRACT

Studies of resilience highlight the tension between actions that allow a firm – and a system – to be robust and those that allows it to be flexible. Studies suggest that an entrepreneurial firm will prioritize flexibility, given resource constraints. However, what occurs when a number of firms are embedded in a common socio-technical system and an extreme event affects them collectively? This paper tests whether existing theory about resilience predicts the responses of entrepreneurs in such a system, with reference to an extreme event in the Bitcoin socio-technical system: the much-publicized bankruptcy of Mt.Gox, a key player. It relies on in-depth interviews with 8 entrepreneurs in Europe, triangulated with other data. We find that robustness is the dominant strategy for those interviewed. This is partly because the firms rely on pooled resources supplied by the collective, and partly because robustness builds trust, giving the firms a competitive advantage.

Keywords: Resilience; Bitcoin; Entrepreneurial Socio-Technical Systems; Theory Testing

1. INTRODUCTION

Studies of resilience in entrepreneurship have typically examined the psychological resilience of the entrepreneurs running the entrepreneurial firm. However, startups, like more established firms, are also part of a broader system. This is typically overlooked when it comes to studies of the resilience of an entrepreneurial firm, despite the acknowledgement that an entrepreneurial firm is comprised of more than just the entrepreneurs who founded it (Tzabbar et al. 2008). Studies of resilience have highlighted a tension between a firm's need to be robust and absorb the effects of a shock, and its desire to be flexible and maneuver to avoid the worst effects of a shock. Given that entrepreneurial firms are typically flexible and resource-constrained (Sine et al. 2006), common sense tells us that it is more unlikely to be robust enough to absorb an exogenous shock. However, where an entrepreneurial firm is part of a larger socio-technical system, this may not be the case.

In this paper we test an existing theory about resilience through a case study of an entrepreneurial socio-technical system, that of the Bitcoin digital payment and transfer protocol, using a coding template drawn from previous literature. We examine the responses of Bitcoin firms to the collapse of what was then one of the most prominent figures in the Bitcoin community, the exchange Mt.Gox. We draw on resilience literature from population

Manuscript first received/*Recebido em:* 26/08/2015 Manuscript accepted/*Aprovado em:* 28/02/2016

Address for correspondence / Endereço para correspondência

Marcel Morisse, University of Hamburg, Hamburg, Germany E-mail: morisse@informatik.uni-hamburg.de

Claire Ingram, Stockholm School of Economics, Stockholm, Sweden E-mail: Claire.Ingram@hhs.se

ecology and organization theory to extend our understanding of entrepreneurial resilience beyond just the psychological traits of the individual entrepreneurs involved, generate an understanding of technical resilience in an entrepreneurial ecosystem (Burnard and Bhamra 2011; Starr et al. 2003).

We therefore ask the question: *Does existing literature on organizational resilience predict the strategies employed by Bitcoin entrepreneurs when an extreme event affects their socio-technical system?*

The paper is structured as follows: in the first section, concepts around resilience in an entrepreneurial socio-technical system are introduced and defined. In the second section we describe the socio-technical Bitcoin system and the nature of an entrepreneurial firm. Third, we discuss our methods and how we developed the theoretical template we used to narrow our research in this complex system. Finally, we discuss our findings and the theoretical contribution of this paper to research on technical resilience in an entrepreneurial socio-technical system.

2. THEORY TESTING: RESILIENCE IN AN ENTREPRENEURIAL SOCIO-TECHNICAL SYSTEM

Resilience is a relatively recent import in the social sciences (Martin 2012) and its definition is still relatively contested. A general definition treats resilience as the ability to respond to disturbance without regressive behavior (Horne and Orr 1998). Studies of economic systems have typically used a narrower definition of resilience, which refers merely to the ability of a system to “bounce back” (Dawley et al. 2010, p. 652) or resist external crises (Simmie and Martin 2010) and thus generate consistent economic growth. Studies of resilience in entrepreneurship have looked at the cognitive resilience of individual entrepreneurs, rather than resilience on the system or field level (Ayala and Manzano 2014).

An entrepreneurial firm, defined as a venture that materializes as a result of “a creative and social/collective organizing process” (Johannisson 2011, p.137), often struggles to survive shocks to the system in which it operates. Like a more established firm, the possibility of an unforeseen event is ever-present with extreme events ranging from natural catastrophes (e.g., earthquakes) to man-made disasters (e.g., terroristic attacks) to accumulations of disruptions in organizational processes (Vogus and Sutcliffe 2007). Studies of such unforeseen events in the context of mature firms suggest that these shocks may have devastating effects because a firm’s ability to react and adapt to such a shock may be overwhelmed (Gutschick and BassiriRad 2003). A mature firm, however, will typically have more resources to deal with an exogenous shock (Mosakowski 1998), as well as structures in place to respond to market or system shocks (Gilbert 2005; Shane 2003; Sine et al. 2006). In contrast, entrepreneurial firms have more organic structures and fewer resources (Sine et al. 2006). While this may give them the flexibility to “pivot” easily, it does not necessarily give them the technical robustness to absorb such shocks.

Fingleton et al. (2012) point to the fact that studies of resilience in economic systems have been largely conceptual in nature. Indeed, the most recent global financial crisis highlighted how little we understand about resilience in practice (Williams et al. 2013). This is also true of entrepreneurship where, despite increased recognition that it is an important contributor to job creation and economic growth, entrepreneurial resilience on a system-level has been largely ignored. Instead, studies of resilience in entrepreneurship have looked at the cognitive resilience of individual entrepreneurs. Findings suggest that self-confidence breeds resilience, even after past failures (Hayward et al. 2010) and that hardiness, resourcefulness

and optimism are predictors of entrepreneurial success, albeit to varying degrees (Ayala and Manzano 2014). However, studies of resilience in a system require an examination of more than the traits of the individuals involved, although in the aggregate they may contribute to the resilience of the whole system. This line of reasoning is consistent with a move away from trait-based entrepreneurship research which has been criticized for over-emphasizing the agency of an individual entrepreneur and ignoring the system in which the entrepreneur operates (Davidsson and Wiklund 2001). In its stead, both explorations of behavioral and cognitive issues among entrepreneurs (Shane and Venkataraman 2000) and context and process studies of entrepreneurship (cf. Aldrich and Ruef 2006; Sarasvathy 2001; Steyaert 2007) have emerged.

This paper takes a process-driven, system-level approach to technical resilience in entrepreneurship by relying on resilient systems literature. In particular, we examine this literature's applicability to entrepreneurship in a complex socio-technical system, through a case study that is particularly revelatory (Eisenhardt and Graebner 2007).

While the definition of resilience remains broad and contested, the definition used in this paper takes a middle road, arguing that resilient behavior combines the mechanisms of flexibility and robustness "to proactively adapt to and recover from disturbances that are perceived within the system to fall outside the range of normal and expected disturbances" (Boin et al. 2010, p. 8). In using this definition, we draw on previous literature around resilient systems both to justify our use of this broad definition and to form the foundation for the coding template, discussed further below, that we used in our empirical analysis.

3. BITCOIN AND THE EXTREME EVENT IN QUESTION

Bitcoin is the best known of the many cryptocurrencies that have emerged in recent years. It was originally conceived of as a way to make electronic transactions over the internet cheaper and less cumbersome by replacing a trusted intermediary with an infallible cryptographic system (Nakamoto 2008). Bitcoin comprises two parts: an open-source protocol ("the Protocol") and a currency ("Bitcoin"). The Bitcoin currency is built upon a cryptographic protocol which allows users to receive and send payments over the internet—identified only by their IP addresses—giving users a semblance of anonymity (Meiklejohn et al. 2013). Every transaction is confirmed by a network of computers, or "miners", and entered into a common ledger, with copies of all past transactions stored by all participants in the network. In exchange for their verification work, miners are rewarded in Bitcoins. The Protocol relies on cryptography and decentralization; it makes transactions more efficient and hopefully cheaper by removing the need for a centralized mediating actor. This lack of oversight has attracted both libertarians, who ascribe it a political identity, and those who wish to conduct transactions that avoid detection (Meiklejohn et al. 2013; Yetis-Larsson et al. 2014).

Both the Protocol and Bitcoin were developed by pseudonymous Satoshi Nakamoto, who released the ideas in an open access format and then, shortly after the first Bitcoin client was created, disappeared. The subsequent development and maintenance of the computer code that executed the Protocol was done by teams of volunteer software developers across the globe, and a number of core developers partly funded by the Bitcoin Foundation.

A single key event occurred just as the Bitcoin price began descending from its peak in January 2014 of 1 240 USD: the closure of a then-dominant Bitcoin exchange called Mt.Gox (hereafter referred to as the Mt.Gox closure). In August 2015 it was worth around 225 USD. At its prime, Bitcoin-USD exchange rates released by Mt.Gox were cited as

representing market prices by the media, its market share of USD-to-Bitcoin exchanges was around 30 percent and Mt.Gox handled approximately 70 percent of all Bitcoin transactions (Vigna 2014). In February 2014, Mt.Gox announced that it was halting all withdrawals, citing security concerns and instabilities in the Protocol, or “transaction malleability”, a bug that led a transaction initiator to believe that her transaction was not confirmed, as reason. At the end of February 2014, Mt.Gox filed for bankruptcy in Japan, declaring around 600 000 Bitcoins were lost or stolen, although the exact amount lost is unknown (Decker and Wattenhofer 2014). Bitcoin experts argue that the reasons Mt.Gox gave for the bankruptcy are unconvincing, but there is no consensus as to what may really have happened (Decker and Wattenhofer 2014).

The reliance on a single, common piece of software, as well as the fact that various groups collaborated to develop and use Bitcoin points to the interdependency between the technical system and the social systems in which it is used. Indeed, our research indicated that not only were the social and technical systems dependent on one another, but the “broader relationship between the technical and social subsystems was one of mutual shaping over time” (Leonardi 2012, p. 40); pointing to the quintessentially socio-technical nature of the phenomenon, embodied in both the Bitcoin currency and the Protocol. Not only this, but the common socio-technical system operates independent of geographic boundaries, given its digital nature, meaning that the socio-technical system is not geographically limited. As one interviewee put it:

“There will be some problems, some small difficulties, but still it is worth using the technology because Bitcoin gives us something more: it is fast, it is secure, it works everywhere in the world, it does not tell you either you can transfer or not, it does not make you exclude it if you live in a poor country or in some kind of a danger zone. Banks won’t open a branch in a danger zone in Africa or somewhere, they say ‘we do not do business here and this is it’ but Bitcoin does not exclude, it just works everywhere. So I think it is the best payment system we have. “

4. METHOD AND CASE STUDY

This paper tests extant theory about technical resilience, with reference to an entrepreneurial socio-technical context. We began by coding interviews using template analysis in order to explore detailed case studies of technical resilience by young entrepreneurial firms. This was done to give us a better understanding of the explanatory power of the social theories around resilience (Langley 1999). While template analysis has been used in a range of epistemological positions, we favor what Madill et al. (2000) call a ‘contextual constructivist’ position; that is, a position that assumes that there are always multiple interpretations of a phenomenon. Such a position relies on template analysis to structure complex and rich qualitative data both in the interests of reflexivity and in order to approach a topic from a particular perspective (King et al. 2004), in this case technical system resilience.

Theory testing is typically conducted within a positivist paradigm of scientific research, together with a quantitative approach (Bitektine 2007, Yin 1981, Yin 2009). However, the use of qualitative research methods to test a theory deductively is not without precedent (See Markus 1983, Shane 2000). Indeed, it has been suggested that:

“In research contexts where unique phenomena, lack of adequate quantitative measures, or reductionist operationalization requiring an unacceptable “leap of faith” make the application of quantitative methods unfeasible, insufficient, or not meaningful, theory

testing using qualitative case studies can provide a critical test for a theory, similar to a test performed with a single experiment (Bitektine 2007, p. 160)”

Our coding was based on eight in-depth interviews, conducted with founding members of young Bitcoin firms across Europe (see Table 1). As the nature of our research question is to understand firms’ responses to extreme events, we decided to conduct a qualitative, theory testing study (Stahl 2014) based on interviews with firms active in this emergent sociotechnical field, as an example of a “particularly revelatory” case (Eisenhardt and Graebner 2007, p. 27).

We identified these firms through reading Bitcoin-related blogs, news media and following social media and then tried to identify some of the individuals behind the firms we had identified. As Europe is a common economic area and users are likely to face similar constraints, and as we are based in Europe, we confined our initial interviews to four countries within the geographical area of Europe. The sample size is small for two reasons: first, given the nascence of the Bitcoin system, each country boasted a very small number of Bitcoin firms. Second, given that there is considerable use of Bitcoins for illicit purposes, we could neither identify the individuals behind it, nor the country of operation, for a number of firms. This is both a limitation of our study and a strength: the firms we interviewed represent nearly the whole population of those operational at the time we conducted our interviews, minus those whom we could not identify.

Firm	Business model
Firm #1	Peer-to-Peer lending using Bitcoins
Firm #2	Bitcoin Consultant Services and Hardware reseller
Firm #3	Business Incubator and Consultant Services
Firm #4	Bitcoin Exchange
Firm #5	Bitcoin Exchange
Firm #6	Retail Exchange
Firm #7	Bitcoin Mining Hardware and Cloud Supplier
Firm #8	Bitcoin Exchange

Table 1: Bitcoin entrepreneurial firms interviewed

We then conducted semi-structured interviews with the CEOs or founders of these entrepreneurial firms over Skype, Google Hangout and, where possible, face-to-face, supported by a broad interview guide. We fine-tuned the guide for each interview, based in part on our understanding of the events that occurred and in part on the literature on resilience. These interviews lasted 30-70 minutes each and were transcribed and, after reading and re-reading (Rice and Ezzy 1999) them, we coded them using Atlas.ti, based on a template of codes derived from resilience literature. This template gave us an *a priori* theoretical orientation which was necessary to get a more sophisticated understanding of resilience in socio-technical systems (Creswell 2013). The derived codes were discussed among the researchers to ensure a common understanding of the meaning of each code and its alignment

to the research question. Finalized codes were then saved to a code table. Each research member analyzed the transcripts of all Bitcoin entrepreneurial firms interviewed. In order to minimize errors, we both familiarized ourselves with the system through reading other sources and triangulated the contents of the interviews with other data sources and other interviews (Strauss and Corbin 1994, Vaast and Walsham 2011). This also enabled us to code our data with an increased sensitivity leading to deeper insights and understanding of this rich phenomenon. Continuous discussion among the team members during the whole coding process reduced the risk of divergent understanding.

The template we developed for coding was grounded in a close examination of the existing literature on resilience in various technical systems, notably drawing from the literatures on organizational and technical resilience. What follows here is a discussion of the literature we have relied upon and the codes that we developed based on this literature, contained in Table 2.

5. RESILIENCE: A THEORETICAL TEMPLATE

In the literature, different patterns can be found for resilient handling of extreme events. Decision making during extreme events is a very complex task as it may involve multiple decision makers and typically involves time pressures and high levels of uncertainty (Mendonça 2007). Moreover, the consequences of both the event and the reaction to the event may be broadly uncertain because such events are so rare that a firm has limited opportunities to train for and learn from extreme events (Mendonça 2007). Organizations showing sufficient resilient behavior overcome the extreme event and can develop more reliable services and show a higher performance orientation resulting in sustainable business model. What follows is a discussion of behaviors during each of these phases.

5.1. Enabling Resilient Behavior before an Extreme Event

It has been recognized that it is not just a firm's behavior during a crisis that helps it survive it; on the contrary, firms can do a great deal before a crisis occurs, which will allow them to weather the storm. A number of *ex ante* decisions can help a firm either absorb a shock or adapt in the face of it: these decisions include building up redundant resource reserves, decentralizing, investing in diversity and being aware of the situation in which it finds itself.

Spare Capacity and Resources: Different patterns of activity have been described as useful preparation for an extreme event. Hu et al. (2008) suggest that redundancy in the form of resources, such as money, additional stock or extra man-hours, can be kept in reserve to be used in tough situations. Although keeping operational resources as backup is expensive, it has been argued that their related costs should be seen as an insurance premium (Sheffi and Rice 2005), based on a cost-benefit calculation wherein the cost of having redundancy is weighed up against the potential losses of an extreme event. (Sheffi 2005).

Human and financial resources, in particular, help create a buffer against an extreme event (Sullivan-Taylor and Branicki 2011). Gittell et al., examining the impact of the 9/11 attacks on the airline industry, found out that “*two factors—cash on hand and debt load—are important contributors to resilience, or the extent to which a firm can withstand a financial crisis. Cash on hand is crucial for coping with the immediate resource demands that arise in a crisis, and a low debt/equity ratio is necessary for coping with the medium- and long-term exigencies of a crisis*” (2006, p.319). Additional employees also allow a firm to respond

quickly and directly to an event (Lengnick-Hall et al. 2011). Entrepreneurs typically struggle to maintain slack financial and personnel resources; almost all resources are needed to establish and grow their businesses (Sullivan-Taylor and Branicki 2011).

Robustness and Stability: In addition, redundancy can be used to build up robustness and stability as it creates a buffer that reduces the fragility of a technical or organizational structure (Zhang and Lin 2010). Pal et al. (2014) analyzed Swedish textile and clothing SMEs and suggested that stabilized processes and reduced supply chain variability enhanced the resilience of an organization. Tierney and Bruneau (2007) also consider robustness to be a major contributor to organizational resilience as it allows a firm to withstand disaster forces.

Flexibility: It has also been argued that when uncertainty around future events is high, organizations should invest in flexibility as it allows to cope with uncertainties and to adapt to harsh situations (Gibson and Tarrant 2010; Grote et al. 2009). Flexibility, here, is achieved through the decentralization of decision making and a low level of formalization (Burnard and Bhamra 2011). This is because when an organization strongly depends on central hubs, should a hub break down due to an extreme event, the remains of the organization are likely to dissolve into smaller, uncoordinated pieces (Janssen et al. 2006). A strong organizational identity can support flexibility in an organization as it supports change and rearrangements of structures and processes (Hatun and Pettigrew 2006).

Such flexibility extends to what has been called a “culture of resilience” (Mallak 1999), which entails preparing the organization for open-ended responsiveness and preparedness for extreme events (Alesi 2008; Walker and Cooper 2011).

Diverse offerings: Flexibility can also be supported by diversity (Fiksel 2003). Organizations which decentralize their decision making and aim for a diversified work force are said to be able to attract diverse skills in extreme situations. In addition, autonomous, highly skilled employees support the rearrangement of process and work tasks, while strong customer relationships allowed an organization to withstand extreme situations (Sheffi 2005). It has also been found that product and service diversification and diverse business strategies mean that a firm can, when in distress, rely on alternatives to lower the impact of an extreme event (Fiksel 2003)

Unique offerings: The business model itself can be a valuable resource in a stressful situation. Organizations that provide unique, non-substitutable services can “*obtain resources, concessions, and assistance that other organizations are denied*” (Lengnick-Hall and Beck 2005, p. 752), for instance because a brand is particularly strong or because the product or service that is provided cannot be easily replaced. Moreover, this uniqueness may mean that employees feel a stronger commitment for their organization during the extreme event (Milanzo and Weeks 2014).

Contextual awareness: Such uniqueness may be a strategic decision by the firm; indeed, resilient behavior is also supported by contextual awareness. Contextual awareness “*incorporates an enhanced awareness of expectations, obligations, and limitations in relation to the community of stakeholders, both internally (staff) and externally (customer, supplier, consultants, etc.)*” (McManus et al. 2008, p.83) and provides a better precognition for future distress situations. Such awareness gives an organization an understanding of the network within which they operate and find potential partners to fight extreme situations.

5.2. Resilient Behavior during a Crisis

Information gathering: When an extreme event occurs, an organization which

quickly gathers information about the event, raises situational awareness, and makes sense of the event and how to respond to it, is thought of as more resilient. However, information gathering under stress may be a difficult task as established communication channels might have broken down; reliable information may therefore be unavailable (Comfort 2002a). A resilient organization can perform a quicker and more reliable information search and exchange, and confirm its findings with partners relying on pre-existing contextual awareness (Comfort 2002b).

Situational awareness and sensemaking: Based on the information gathered, a resilient organization can gain a situational awareness and come to understand what has occurred (Seville 2008). The specifics of the event can be registered and included in the sensemaking process, facilitating forward planning (Vogus and Sutcliffe 2007). Sensemaking during stressful situations has to be carried out carefully as the *“less adequate the sensemaking process directed at a crisis, the more likely it is that the crisis will get out of control”* (Weick 1988, p. 305). Both awareness and the sensemaking process provide the basis for recovery after an extreme situation. Using *“quick, adaptive, integrated & comprehensive, expedited actions”* (Mousavi et al. 2012, p. 7) regressive behavior can be stopped as soon as possible and with acceptable cost and time (Haimes 2009b).

Resilience Template and Codes	Literature
Before the Event	
Spare Capacity and Resources	Gittell et al. 2006; Hu et al. 2008; Lengnick-Hall et al. 2011 Sheffi 2005; Sheffi and Rice 2005; Sullivan-Taylor and Branicki 2011
Robustness	Pal et al. 2014; Tierney and Bruneau 2007; Zhang and Lin 2010
Flexibility	Alesi 2008; Burnard and Bhamra 2011; Gibson and Tarrant 2010; Grote et al. 2009; Hatum and Pettigrew 2006; Janssen et al. 2006; Mallak 1999; Walker and Cooper 2011
Diverse offerings	Fiksel 2003; Fiksel 2006; Sheffi 2005
Unique offerings	Lengnick-Hall and Beck 2003; Lengnick-Hall and Beck 2005; Milanzo and Weeks 2014
Contextual awareness	McManus et al. 2008
During the Event	
Gathering information	Comfort 2002a; Comfort 2002b
Situational awareness	Haimes 2009a; Haimes 2009b; Mousavi et al. 2012; Vogus and Sutcliffe 2007; Weick 1988
Stability	Erol et al. 2010; Haimes 2009b; Smith and Fischbacher 2009; Walker et al. 2004
Adaptability	Borekci et al. 2013; Comfort 2002a; Folke et al. 2004; Hamel and Valikangas 2003; Linnenluecke and Griffiths 2010; McCann et al. 2009; Ponomarov and Holcomb 2009;

	Woods 2006
After the Event	
Reliability	Abbadi 2011
Recovery / Overcoming Extreme Event	London and Smither 2002; Vogus and Sutcliffe 2007
Availability	Abbadi 2011

Table 2: Resilience codes based on extant literature

Stability and Adaptability: An organization is said to return to a stable state if it can retain pre-existing functions, structures or identities (Walker et al. 2004) or find a new equilibrium within acceptable degradation parameters (Erol et al. 2010; Haines 2009b; Smith and Fischbacher 2009). Another way to overcome an extreme event is through adaptation (Comfort 2002a); “*the amount and variety of resources and skills possessed and available for maintaining viability and growth relative to the requirements posed by the environment*” (McCann et al. 2009, p.45) provide the basis for this adaptation and allow an organization to develop new abilities or capabilities (Borekci et al. 2013; Woods 2006). Such adaptation may include reinventing a business model to create a sustainable competitive advantage (Hamel and Valikangas 2003; Ponomarov and Holcomb 2009). An organization may also reorganize its structure and processes to minimize the impact of an extreme event (Folke et al. 2004; Linnenluecke and Griffiths 2010).

5.3. Results of resilient behavior after an extreme event

Recovery: Both knowledge gathered and the manner in which an organization responds to an extreme event are predictors of an organization’s ability to recover (London and Smither 2002; Vogus and Sutcliffe 2007), whether because it absorbs the shock of the event or adapts in the face of it. Thus, a resilient organization achieves “*higher availability and reliability, as its design approach focuses on tolerating and surviving the inevitable failures*” (Abbadi 2011, p. 143).

6. FINDINGS AND ANALYSIS

The following section is devoted to our results derived from the interviews, followed by an analysis of these results. The analysis is based on the theoretical frame and codes developed in the previous section.

6.1. Enabling Resilience: Behavior before an Extreme Event

Our strongest finding was that the complex system in which the entrepreneurial firm operated was an important source of technical and organizational resources. The entrepreneurial firms drew on these resources, which allowed them to respond to the extreme event with little to no preparation (see Table 3).

Spare resources and capacity: The entrepreneurial firms, unsurprisingly, did not have significant resources that they could keep slack in the event of a crisis. Indeed, the need

for spare resources and capacity was only mentioned by one interviewee as something that they had implemented. Most of the interviewed entrepreneurial firms devoted their resources to growing the firm, meaning that they could not hold resources back (#4, #8). One interesting finding was that although the entrepreneurs did not keep spare resources aside, they *aspired* to have more slack resources, notably financial ones. They therefore spent much of their time trying to find external investors in order to make sure that their firms survived (#1). Risk management and business continuity management, which can contribute to organizational resilience, were not used at the interviewed organizations.

Moreover, the other firms argued *ex post* that even given what they had learned from the event, they did not see redundant, spare resources as necessary for their survival. This was because of the nature of the socio-technical system in which they were operating: Bitcoin itself was considered to have built-in redundancy, so that organization embedded in the Bitcoin context did not need to implement further redundancy in their systems (#1). The entrepreneurs did, however, employ additional employees as “*having redundancy on the personnel side is the most important thing*” (#1). For the future, many planned to rebuild their technical infrastructure and include more redundancy in their technical system, if cost-effective (#1).

Robustness: While the firms relied on the redundancy inherent in the socio-technical system, they also emphasized robustness within their own firms, largely when they compared their own firms with the bankrupt firm Mt.Gox. Mt.Gox’s lack of robustness, they argued, was evident in Mt.Gox’s failure to use appropriate technologies and standards (#1; #3, #6), lack of internal oversight (they apparently did not keep track of past versions of their platform) (#3), and lack of transparency (by keeping their code secret) (#8). In addition “*their business infrastructure, from a technological standpoint and from an employee standpoint, wasn’t ready to scale to such big trading volumes, and wasn’t handled professionally enough for the scale that actually came through in a very short amount of time*” (#1). They argued that Mt.Gox had not developed their business in an appropriate way, despite the fact that the Bitcoin system depended on them (#6).

Flexibility: Small, entrepreneurial firms are known for their high levels of flexibility; so the ability to be flexible was something that the firms largely took for granted. Indeed, the challenge for the entrepreneurs was to “*be robust and flexible at the same time.*” (#3), given their limited financial and human resources. They tried to deal with this challenge by staying as lean as possible (#1). They also pointed to the importance of their technical infrastructures, arguing that it should be built with the capacity to adapt to business model changes, for instance if they wished to add alternative cryptocurrency into their current business model (#1, #3, #4, #8). The interviewees considered the ongoing discussion around Bitcoin regulations to be a barrier. Should regulation occur, most were prepared to move their firms to countries with more favorable regulations (#2, #8).

Diverse offerings: While the interviewed entrepreneurs acknowledged that the socio-technical system which they were part of gave them considerable room to maneuver, they also pointed out that it was not enough on its own. Firms therefore took additional measures to ensure that both they and their customers were safe. One entrepreneur suggested that a “*mix of automation and manual oversight gives a very good combination*” (#4), referring to screening transactions, and argued that it gave the entrepreneur the chance to intervene if a situation seemed suspicious. Another entrepreneur established different bank accounts in several European countries to mitigate the institutional risks inherent in the new socio-technical ecosystem, for instance the risk of a closed bank account (#8). Interviewees also started to include more business partners in their business models and diversified their

supplies (#4, #6, #7). In addition to their own efforts, entrepreneurs also saw the need to educate their customers on the importance of technical diversity, suggesting that they store their Bitcoins in different devices or at several exchanges (#2, #3).

Geographic diversity and decentralization were seen by the entrepreneurs as being a necessary evil; something that they would prefer not to have, but which was necessitated by the shortage of experienced employees (#1, #8). Consequently, firms worked in small teams, which were oftentimes distributed in different cities and countries (#1). This placed, limitations on the entrepreneurial firms' ability to recognize potentially harmful situations and respond to them quickly.

Unique offering: Providing unique, non-substitutable services was mentioned often among the Bitcoin entrepreneurs. *"The first mover advantage seems to apply to Bitcoin"* (#8). In addition, Bitcoin itself was considered to be a unique, non-substitutable service, as one entrepreneur pointed out:

"People can exchange cash for services without any kind of trust [offline], they can essentially just move cash around. It is a huge economy, it's probably the biggest one around... [but] the cash part of the internet is really what is missing today and it's something that is a huge advantage [in Bitcoin]" (#8).

However, this uniqueness was only in relation to existing financial service firms, rather than other entrepreneurial firms. Few entrepreneurs realized the importance of distinguishing themselves from other Bitcoin firms until after the Mt.Gox bankruptcy; instead they pointed to the uniqueness of the entire Bitcoin ecosystem. Implicit in this is the sense that they perceived potential threats as coming from outside the system, rather than from within.

Contextual Awareness: Raising contextual awareness was a necessity for entrepreneurs in the Bitcoin context. The Bitcoin entrepreneurial system was considered very competitive (#8), and the Bitcoin community forced Bitcoin entrepreneurs to be transparent about their business models and processes through blogs, news forums and documentation (#1, #7). Entrepreneurial firms were therefore compelled by norms in the community to build up contextual awareness, *"it requires more attention and more time, because these spaces are just moving so quickly and there were so many new things happening every day, so actually I'd like to dedicate more time to follow news about Bitcoin specific news"* (#1). However, there was considerable benefit to doing this, the vast quantities of information available online meant that the *"Bitcoin community is very aware of money and economics in comparison to most other people who sign up for a credit card"* (#3).

Resilience Template	Bitcoin System	Examples
Before the Event		
Spare resources sourced from <i>inside</i> the firm.	Spare resources can mostly be found <i>outside</i> the firm.	<i>If it happened then, when the entire ecosystem was much smaller ... I think the impact would have been much worse than it has been now, because the ecosystem as a whole was much more advanced. (#1)</i>
Robustness generated from <i>inside</i> the firm.	Entrepreneurs rely on actors outside the firm.	<i>So we have flexibility so we have money on [X] too, so if [Y] is down one day we can buy from [X], it's a little bit expensive but we take the losses so our customers get their money. (#4)</i>
Decentralization.	Entrepreneurs try to avoid centralization—both inside their firms, and in the Bitcoin system.	<i>Yes, because it is a lesson that needed to be learned. We cannot have centralized institutions holding people's money without any transparency and with incompetent software (#3)</i>
Flexibility.	Flexibility is recognized as important, but entrepreneurs put a stronger emphasis on robustness.	<i>Being flexible is something we have to focus on for the future but right now we're just taking robust measures to make sure we have a clean solid system upon which our customers can use their services (#3)</i>
Diverse offerings.	Entrepreneurs encouraged customers to hold them themselves, not at an exchange.	<i>Basically if a bitcoin user will diversify his funds I think he can sleep well (#2)</i>
Unique offerings.	Entrepreneurs emphasized the importance of offering a niche, or at least, a differentiated service.	<i>[...] being the first ones means to capture the audience if there is a network effect. So I think that is why it is as aggressive as it is when it comes to these types of services [...] There is no one providing fast payments, and hopefully we're next week going live, then we'll be the only ones able to provide that. Which is unique (#8).</i>
Contextual awareness.	Contextual awareness is established through interactions with other system members.	<i>I try to follow the Bitcoin news as closely as my time allows, so if something does come up, that we can react as fast as possible and not just learn about it after one or two days or something (#1)</i>

Table 3: Template Codes and Examples of Resilient Behavior before the Extreme Event

6.2. Resilient Behavior during the Crisis

As most of them followed their own advice and diversified their holdings, few lost much money during the Mt.Gox event. Indeed, while some entrepreneurs lost money because they stored Bitcoins at the Mt.Gox exchange (#4, #6) or sales went down (#1), the firms were largely able to absorb these losses (see Table 4). However, the strongest effects of the crisis are found in three things: 1) their realization that the socio-technical system upon which they had built their businesses was not as robust as they previously thought; 2) they could not immediately establish if their firms had been adversely effected, and 3) they had to deal with customer enquiries about the state of their holdings, something which they could not immediately answer, given the fact that they had not committed many resources to dealing with self-monitoring (#5, #8):

“Our major problem concerning the Mt.Gox thing has been people you meet when you’re out to talk about the [firm] POS system, then someone says I thought Bitcoin went bankrupt. Aah that’s not exactly right. That’s the signal that I really have to start from the beginning with this one. I guess that’s the most damage that this [Mt.Gox] has done” (#4).

Gathering information and situational awareness: Just before or quickly after the Mt.Gox event, the interviewed entrepreneurs started to gather information about the event. One entrepreneur had had previous experiences with Mt.Gox which made him suspicious:

I had few Bitcoins on the Mt.Gox and when I was trying to transfer them to my wallet I noticed some suspicious, some bad behavior, of the exchange and then when I was transferring money from Mt.Gox to my account I realized that they needed 20 or 30 days for a bank transfer. It was very weird for me and I decided to make a small transfer every day from Mt.Gox to my account to see how the things were going, if they were going faster or slower and I was receiving every day a small payment from Mt.Gox and then I realized that the payments were taking longer and longer. At first it was 20 days and few days before the Mt.Gox crashed it was 54 days. I was waiting 54 days for a small payment and I realized that they had serious problems. And I started to inform my readers. (#2)

Other entrepreneurial firms used Twitter, Skype, news forums and blogs to acquire information and plan their next steps (#4). The information gathered was used to create situational awareness, find explanations for the current situation and foresee potential implication for the own business. As one entrepreneur stated, *“no one expected it but no one was surprised”* (#4). Most of the interviewees were aware that Mt.Gox was experiencing technical problems, but didn’t expect their problems to impact the system. Furthermore, entrepreneurs’ situational awareness allowed them to gather reliable information via trusted information channels or partners (#1). Based on the situational awareness and the information gathering, entrepreneurs started to find explanations for the extreme events. This sensemaking was often supported by business partners or in discussion with members of the Bitcoin community.

“I think it is fair to say that the other board members of the [firm] have a fairly similar view on this event as the one I have, because we immediately discussed it, so this is something that we really talked about, to have a standpoint” (#1)

As no watertight information was available after the Mt.Gox event, most of the sensemaking was based on unauthenticated speculation (#5). Therefore, the explanation for these problems ranged from managerial incompetence (#1, #3 #5, #6, #8) to technical faults (#3, #5) to fraud (#2).

Stability and Adaptability: The *foci* of the firms were twofold: 1) to assess the

damage and 2) to reassure people not just of the stability of the individual firm, but the socio-technical system in general. Trust had to be regained. Bitcoin entrepreneurs therefore invested a substantial portion of their limited resources in ensuring the stability of the Bitcoin system as this was to the benefit of the individual firm. They rechecked technical infrastructure (#5), and customer funds were audited by third parties (#5, #8) to reassure users of the availability and reliability of the firm. All firms found that they retained their functionality and that their individual systems were unaffected. However they claimed that they needed to go to some lengths to reassure others of the stability of the Bitcoin system: in particular, they had to convince their customers that the Mt.Gox event was a single firm's problem and not caused by Bitcoin itself (#2).

Media attention rose and many entrepreneurs spoke to the press and explain their understanding of the Mt.Gox event (#1, #4, #5, #8). Together with the rising media attention, legislators became more aware of the Bitcoin ecosystem, and discussed possible regulations and controls to prevent further collapses and to sanction illicit behavior. The interviewed entrepreneurs needed to present their view on Bitcoin to the legislators:

“And then we also, together with some of the biggest Bitcoin companies, we're commenting on different proposals on legislations that are put forward to the regulators” (#8).

Resilience Template	Bitcoin System	Examples
During the Event		
Gathering information	Information was gathered via various channels like blogs, skype and discussion forums	<i>At least I wasn't surprised, let's put it his way, because a lot of people were saying that something is wrong with them (#1)</i>
Situational awareness	Entrepreneurs were not surprised by the Mt.Gox downfall	<i>I think they asked for some documents, like they wanted from me to show them a copy of my passport or something like this and they were trying to make me not take the bitcoins from the system (#2).</i>
Stability	Stability was a valid option as the socio-technical system absorbed the disruptions	<i>Well it wasn't so small, but the good thing was that at that point at which it came out, I think it was in February 2014, the ecosystem was big enough to absorb it (#1).</i>
Adaptability	The entrepreneur could reorganize their procedures, if necessary.	<i>I guess Mt.Gox was just a way to clean up the market. And for a lot of businesses looking to buy bitcoins, they just moved to other platforms (#8)</i>

Table 4: Template Codes and Examples of Findings during the Extreme Event

6.3. Results of Resilient Behavior after an Extreme Event

Shortly after the Mt.Gox bankruptcy, recovery began (see Table 5). The Bitcoin firms' fight to re-establish trust in the system was an integral part of this.

Some of the entrepreneurs interviewed avoided storing customer funds as this required more staff and more security to mitigate the risk of hacking and losing of customer funds (#4). One organization brought in an external expert to discuss extreme scenarios and to test their system to strengthen the robustness of the technical infrastructure. Another one established a customer-relationship-management system to improve the tracking of customer orders (#3). However, despite the fact that the shock was to the collective system, the firms found that the very same Bitcoin system could itself be helpful in the recovery. This was due to how engaged and committed the Bitcoin community was; it served to support the firms operating in the system and aided firms in persuading users to distinguish between the distress at Bitcoin service providers and distress in the system itself (#3).

The lack of professionalism on the part of Mt.Gox was depicted as being a lesson that the interviewed entrepreneurs thought that they could learn from. Moreover, they thought that the unprofessional light that it cast on the community was one that they could use to their own firm's advantage – by emphasizing their own professionalism. Indeed, they tried to position themselves as different from Mt.Gox (#8) and thus unique within the system:

“We try to have, not to be a too messy startup, essentially to keep our things in order, ensure that people are paid salaries, ensure that we have policies inside the company that we can show to investors that we have, for example, policies around KYC [Know Your Customer] that we can show to regulators and banks” (#6).

These actions allowed Bitcoin entrepreneurs to overcome the collapse of Mt.Gox and continue their commercial activities. As one entrepreneur remarked: *“Well, that is the current situation, the last months have been very quiet. We passed through the ‘valley of tears’, I think we regained the lost trust” (#5).* The interviewed entrepreneurs believed that they could retain their availability and reliability but see the Mt.Gox event as *“a warning signal to businesses who want to operate on a legit and professional basis” (#1).* Indeed, most of the entrepreneurs interviewed considered the Mt.Gox incident a positive one: as *“a bad apple falling from the tree” (#4).*

Resilience Template	Bitcoin System	Examples
After the Event		
Reliability	Both the robustness of the entrepreneur and that of the system contributed to resilience.	<i>I think, we just have to accept this and we are doing everything that we can do, what is recommended to us and what will be maybe required to do (#5).</i> <i>We did write something about the Mt.Gox debacle, I wrote that this is kind of like when a bank goes under and you don't lose faith in the Swedish crown or the pound just because one bank went under (#4).</i>
Recovery / Overcoming Extreme Event	Media and regulator attention rose after Mt.Gox's closure; the entrepreneur had to dedicate additional resources to appeasing them.	<i>Because of the Mt.Gox incident, the regulators move with huge caution and want to avoid a similar incident in Germany, which I understand. People, who are responsible for licensing such platforms in Germany, want to eliminate the chance, that something like this can happen in Germany (#5)</i>
Availability	The entrepreneurs built their business models with the technical infrastructure in mind.	<i>Digital currencies are here to stay, Bitcoin maybe not (#4).</i>

Table 5: Template Codes and Examples of Findings after the Extreme Event

7. DISCUSSION AND THEORETICAL CONTRIBUTION

All of the entrepreneurial firms interviewed survived the Mt.Gox event. They showed diverse strategies of technical and organizational resilience before, during and after the crisis (see Tables 3-5). However, some findings stood out as surprising given what we know about entrepreneurial firms on the one hand, and resilience on the other hand.

7.1 Daily flexibility, long-term robustness

One surprising finding was the emphasis that the firms put on being robust, in contrast to the flexibility usually associated with entrepreneurial firms. New firms in general cherish their flexibility in that it allows them to respond quickly and cheaply to market and system changes. This characteristic is considered important in a fast-moving system where new entrepreneurs are entering the market with new business models and ideas, as in the Bitcoin system. Instead the entrepreneurs we interviewed emphasized the importance of

robustness. Framing this finding, one explanation might be that given the fragility of this system and despite the pace at which it was changing, the firms presented themselves as robust in order to seem “stable” in a system that was not quite fully trusted. Such a position allowed them to stand apart from other Bitcoin firms and attract new customers. This points to another finding: robustness and flexibility can be complementary, not contradictory. In this development, a robust and mostly stable foundation is necessary in order to be flexible and respond quickly to market changes. During day-to-day business, this robust foundation is taken for granted and “forgotten”. But when an extreme event occurs, the robustness of the foundation is drawn upon and emphasized more than flexibility. This allows entrepreneurs to overcome extreme events more quickly and return to the day-to-day parts of running their firm.

This competitive advantage extended to a less unsurprising finding: the importance of standing out in the Bitcoin system. Indeed, finding a niche and offering a unique service can be done more easily in a young entrepreneurial socio-technical system, whereas in a more mature system many niches are already occupied. Finding a niche allows a firm to focus on building its business and accumulating resilience-reinforcing resources, relying on its unique offering to attract and keep customers. More interestingly, it became clear during the interviews that robustness itself, although not explicitly labelled as such, was a niche-exploiting strategy that allowed entrepreneurs to stand out from their competitors. Robustness, which is also a resilient strategy, was therefore a competitive advantage.

7.2 Collective resilience in the face of external complexity

The socio-technical system upon which the Bitcoin entrepreneurial firms relied proved to be an integral part of why the crisis occurred and why it affected so many firms. Moreover, this independence tainted the firms involved, one which many still have not shaken off. However, the system provided two resources that helped the entrepreneurs prepare themselves for the crisis: first, the system itself contained enough slack that the entrepreneurs could rely on that slack and focus on other survival mechanisms. Second, the social communication links between the firms in the system meant that information gathering and dissemination was done collectively; thus more effectively.,

This “collective resilience” has been examined inside an organization (see Drury et al. 2013); however it has never before been seen in a sociotechnical system. By rallying together, the firms could assert the independence of the system from the single firm that had collapsed. This function was very effective for morale among the companies involved, although it was less effective in influencing external opinions of the bankruptcy. These external opinions were a key part of why the event had the effect that it did. Interviewees pointed out that the event itself had little effect but that the media constructed meaning out of the event – and that this was the most detrimental to their firms.

This increase in attention meant not only that the entrepreneurs had to be passively aware of the context in which they found themselves, but that they had to proactively anticipate the media’s questions and the accusations. Indeed, the media maelstrom drew regulators’ attention. This could either have stabilized the system through regulation and legitimation, or destabilized the system by disrupting the firms’ businesses further. This was something that the firms could not predict – and they therefore had to play an active role in shaping the narrative outside their firm and the immediate Bitcoin system. This differs from other studies of resilience, where the shock to a system manifests largely in the complexity *inside* the system. Instead, here, the event led to external complexity – which had a knock-on

effect on the Bitcoin socio-technical system.

7.3 Shared identity a double-edged sword

Ultimately, we also find that the same things that make the system – and thus the firms in it – more resilient also have unintended negative consequences. For instance, the close identity and sense of community that the firms had meant that they helped each other, but they also acknowledged that it was hard for them to distinguish their business from the collective platform– both when it came to the underlying technology, and when it came to other firms. The firms therefore had to rely on narratives to distinguish themselves – and to isolate the failed firm that had rocked the system.

The strength of this collective identity and belief both in the protocol and in the underlying Bitcoin community, according to the entrepreneurs, gave them flexibility in their strategies. One of the technical characteristics of the Bitcoin system noted several times in relation to resilient strategies was decentralization; these entrepreneurs strongly recommended that users not keep their Bitcoins in a single, central place. However, despite arguing that doing this in practice - and the ability to do this in general - was a strength of the Bitcoin field socially as well as technically, many of them argued for centralization in other areas. In particular, some entrepreneurs argued that the Bitcoin field needed more regulation in order to keep businesses and users safe and to build confidence in the system.

In the same vein, the perceived importance of the community was reflected both in the language that the entrepreneurs used and in the stark line that was drawn between “insiders” and “outsiders”, with insiders presumed to be somewhat Bitcoin-savvy and outsiders depicted as ignorant and possibly even guilty of malicious intentions towards Bitcoin. On closer inspection, this insider-outsider narrative is the same one used to explain the necessity of Bitcoin because existing actors like banks and central governments did not have the best interests of the ordinary person at heart, whereas Bitcoin as a decentralized and anonymous currency did.

Our theoretical contribution is therefore threefold: first, we find that resources and flexibility are as important as ever in a complex socio-technical system. However, in contrast to actors in other systems, resources here are pooled and collective identity and common interests maintain interactions and the continued pooling of resources. Second, we find that collective actions and these pooled resources supported resilience. Moreover, there was little complexity *inside* the effected firms. Rather, the firms had to anticipate complexity in the broader system and respond to that. Lastly, we find the very identity that caused firms to share resources with one another, and the collective; this collective identity also tainted them.

8. CONCLUSION AND LIMITATIONS

In conclusion, this paper gives insights on how entrepreneurial firms in a socio-technical system like Bitcoin can be resilient. We tested an existing theory about resilience, drawing on organization and population ecology literature, with reference to a young socio-technical ecosystem in which new, entrepreneurial firms operated: that of Bitcoin. We analyzed technical resilience in this system in three stages: pre-crisis, during the crisis and after the crisis.

We find that much of the existing resilience literature *does* apply in the case of this emergent socio-technical system, but that there are some exceptions to this. First, although

knowledge of entrepreneurial firms would predict flexibility during an extreme event, firms in this system instead pursued both robustness and flexibility simultaneously. The robustness apparently gave them a comparative advantage and assisted them in building trust in the face of such a fast-moving system. Second, although these entrepreneurial firms individually had few resources, their participation in the socio-technical system meant that they had access to a number of pooled resources pre-crisis; this meant that they did not have to put aside slack resources to the same extent predicted by theory. Pooling and cooperation were driven and maintained by a collective identity and common interests. Thirdly, participation in this socio-technical system was not all positive. Both during and after the crisis, firms struggled to differentiate themselves from their competitors, including the bankrupt Mt.Gox which prompted the crisis. This struggle to stand out also manifested itself in the media scrutiny that followed the crisis, which drove the firms not only to make sense of how the event would directly affect them, but also how the event would be interpreted by outside actors. Thus, they not only had to anticipate the responses and sensemaking processes of external actors, but also to actively engage with them in order to mitigate the indirect effects of the crisis.

As with all research, this research is not free of limitations, and the limitations are twofold. First, the theoretical frame which has been used to code the interviews is based on a limited set of literature. Although different research areas have been analyzed in developing the coding scheme and subsequent theory testing, additional literature might have further enhanced the insight on entrepreneurial resilience. Second, all companies interviewed survived the extreme event in question. Furthermore, the interviewees adapted their narrative based on self-interest and self-defense. As described above, we believe that defending the system is an appropriate resilient strategy but may bias the findings. Of note is the fact that our aim was not to generate generalizable results, but test the predictive power of an existing theory in the context of a specific case.

Our main contribution was therefore the finding that firms in such a system rely on each other in much the same way as actors within a single firm might – indeed the system’s collective identity means that outside actors often cannot distinguish the firms from the system in which they operate. This has implications for future researchers and managers. For instance: How do these entrepreneurs distinguish themselves from the collective, while still drawing on resources for the collective? How can these shared resources be effectively managed for the benefit of both the collective and the constituent firms? We therefore recommend further research into the role of entrepreneurial firms in a broader socio-technical system to test the boundaries of this finding, as well as ascertain the role of collective identity in forming such a system, its role in stabilizing a system and in maintaining shared resources.

REFERENCES

- Abadi, I. M. 2011. “Operational Trust In Clouds' Environment,” In *2011 IEEE Symposium On Computers And Communications (ISCC)*, Corfu, Greece, Pp. 141–145.
- Aldrich, H., And Ruef, M. 2006. *Organizations Evolving*, London: Sage Publications.
- Alesi, P. 2008. “Building Enterprise-Wide Resilience By Integrating Business Continuity Capability Into Day-To-Day Business Culture And Technology,” *Journal Of Business Continuity & Emergency Planning* (2:3), Pp. 214–220.
- Ayala, J.-C., And Manzano, G. 2014. “The Resilience Of The Entrepreneur. Influence On The Success Of The Business. A Longitudinal Analysis,” *Journal Of Economic Psychology* (42), Pp. 126–135.

- Bitektine, A. 2007. "Prospective Case Study Design: Qualitative Method For Deductive Theory Testing," *Organizational Research Methods* (11:1), Pp. 160–180.
- Boin, A., Comfort, L. K., And Demchak, C. C. 2010. "The Rise Of Resilience," In *Designing Resilience: Preparing For Extreme Events*, L. K. Comfort, A. Boin And C. C. Demchak (Eds.), Pittsburgh, Pa: University Of Pittsburgh Press, Pp. 1–12.
- Borekci, D., Rofcanin, Y., And Sahin, M. 2013. "Effects Of Organizational Culture And Organizational Resilience Over Subcontractor Riskiness: A Multi-Method Study In Longitudinal Time Setting," *European Business Review* (26:1), Pp. 2–22.
- Burnard, K., And Bhamra, R. 2011. "Organisational Resilience: Development Of A Conceptual Framework For Organisational Responses," *International Journal Of Production Research* (49:18), Pp. 5581–5599.
- Comfort, L. K. 2002a. "Managing Intergovernmental Responses To Terrorism And Other Extreme Events," *Publius: The Journal Of Federalism* (32:4), Pp. 29–50.
- Comfort, L. K. 2002b. "Rethinking Security: Organizational Fragility In Extreme Events," *Public Administration Review* (62:S1), Pp. 98–107.
- Creswell, J. W. 2013. *Qualitative Inquiry And Research Design: Choosing Among Five Approaches*, Los Angeles: Sage Publications.
- Davidsson, P., And Wiklund, J. 2001. "Levels Of Analysis In Entrepreneurship Research: Current Research Practice And Suggestions For The Future.," *Entrepreneurship Theory And Practice* (25:4), Pp. 81–100.
- Dawley, S., Pike, A., And Tomaney, J. 2010. "Towards The Resilient Region?" *Local Economy* (25:8), Pp. 650–667.
- Decker, C., And Wattenhofer, R. 2014. "Bitcoin Transaction Malleability And Mtgox," In *Computer Security - ESORICS 2014*, M. Kutylowski And J. Vaidya (Eds.), Cham: Springer International Publishing, Pp. 313–326.
- Drury, J., Novelli, D., And Stott, C. 2013. "Representing Crowd Behaviour In Emergency Planning Guidance: 'Mass Panic' Or Collective Resilience?" *Resilience* (1:1), Pp. 18–37.
- Eisenhardt, K. M., And Graebner, M. E. 2007. "Theory Building From Cases: Opportunities And Challenges," *The Academy Of Management Journal* (50:1), Pp. 25–32.
- Erol, O., Henry, D., Sauser, B., And Mansouri, M. 2010. "Perspectives On Measuring Enterprise Resilience," In *2010 IEEE International Systems Conference*, IEEE, Pp. 587–592.
- Fiksel, J. 2003. "Designing Resilient, Sustainable Systems," *Environmental Science & Technology* (37:23), Pp. 5330–5339.
- Fiksel, J. 2006. "Sustainability And Resilience: Toward A Systems Approach," *Sustainability: Science, Practice, & Policy* (2:2), Pp. 14–21.
- Fingleton, B., Garretsen, H., And Martin, R. 2012. "Recessionary Shocks And Regional Employment: Evidence On The Resilience Of U.K. Regions," *Journal Of Regional Science* (52:1), Pp. 109–133.
- Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., And Holling, C. S. 2004. "Regime Shifts, Resilience, And Biodiversity In Ecosystem Management," *Annual Review Of Ecology, Evolution, And Systematics* (35), Pp. 557–581.
- Gibson, C. A., And Tarrant, M. 2010. "A 'Conceptual Models' Approach To Organisational Resilience," *The Australian Journal Of Emergency Management* (25:2), Pp. 6–12.
- Gilbert, C. G. 2005. "Unbundling The Structure Of Inertia: Resource Versus Routine Rigidity," *Academy Of Management Journal* (48:5), Pp. 741–763.
- Gittell, J. H., Cameron, K., Lim, S., And Rivas, V. 2006. "Relationships, Layoffs, And Organizational Resilience: Airline Industry Responses To September 11," *The Journal Of Applied Behavioral Science* (42:3), Pp. 300–329.

- Grote, G., Weichbrodt, J. C., Günter, H., Zala-Mezö, E., And Künzle, B. 2009. "Coordination In High-Risk Organizations: The Need For Flexible Routines," *Cognition, Technology & Work* (11:1), Pp. 17–27.
- Gutschick, V. P., And Bassirirad, H. 2003. "Extreme Events As Shaping Physiology, Ecology, And Evolution Of Plants: Toward A Unified Definition And Evaluation Of Their Consequences," *New Phytologist* (160:1), Pp. 21–42.
- Haimes, Y. Y. 2009a. "On The Complex Definition Of Risk: A Systems-Based Approach," *Risk Analysis* (29:12), Pp. 1647–1654.
- Haimes, Y. Y. 2009b. "On The Definition Of Resilience In Systems," *Risk Analysis* (29:4), Pp. 498–501.
- Hamel, G., And Valikangas, L. 2003. "The Quest For Resilience," *Havard Business Review* (81:9), Pp. 52–65.
- Hatum, A., And Pettigrew, A. M. 2006. "Determinants Of Organizational Flexibility: A Study In An Emerging Economy," *British Journal Of Management* (17:2), Pp. 115–137.
- Hayward, M. L., Forster, W. R., Sarasvathy, S. D., And Fredrickson, B. L. 2010. "Beyond Hubris: How Highly Confident Entrepreneurs Rebound To Venture Again," *Journal Of Business Venturing* (25:6), Pp. 569–578.
- Horne, J. F., And Orr, J. E. 1998. "Assessing Behaviors That Create Resilient Organizations," *Employment Relations Today* (24:4), Pp. 29–39.
- Hu, Y., Li, J., And Holloway, L. E. 2008. "Towards Modeling Of Resilience Dynamics In Manufacturing Enterprises: Literature Review And Problem Formulation," In *IEEE International Conference On Automation Science And Engineering (CASE 2008)*, Arlington, VA. 23-26 August, Pp. 279–284.
- Janssen, M. A., Bodin, Ö., Anderies, J. M., Elmqvist, T., Ernstson, H., Mcallister, Ryan R. J., Olsson, P., And Ryan, P. 2006. "Toward A Network Perspective Of The Study Of Resilience In Social-Ecological Systems," *Ecology And Society* (11:1), Pp. 1–20.
- Johannisson, B. 2011. "Towards A Practice Theory Of Entrepreneurship," *Small Business Economics* (36:2), Pp. 135–150.
- King, N., Cassell, C., And Symon, G. 2004. "Using Templates In The Thematic Analysis Of Texts," In *Essential Guide To Qualitative Methods In Organizational Research*, C. Cassell And G. Symon (Eds.), London: Sage Publications, Pp. 256–270.
- Langley, A. 1999. "Strategies For Theorizing From Process Data," *Academy Of Management Review* (24:4), Pp. 691–710.
- Lengnick-Hall, C. A., And Beck, T. E. 2003. "Beyond Bouncing Back: The Concept Of Organizational Resilience.," National Academy Of Management Meetings.
- Lengnick-Hall, C. A., And Beck, T. E. 2005. "Adaptive Fit Versus Robust Transformation: How Organizations Respond To Environmental Change," *Journal Of Management* (31:5), Pp. 738–757.
- Lengnick-Hall, C. A., Beck, T. E., And Lengnick-Hall, M. L. 2011. "Developing A Capacity For Organizational Resilience Through Strategic Human Resource Management," *Human Resource Management Review* (21:3), Pp. 243–255.
- Leonardi, P. M. 2012. "Materiality, Sociomateriality, And Socio-Technical Systems: What Do These Terms Mean?" In *Materiality And Organizing: Social Interaction In A Technological World*, P. M. Leonardi, B. A. Nardi And J. Kallinikos (Eds.), Oxford: Oxford University Press, Pp. 25–48.
- Linnenluecke, M., And Griffiths, A. 2010. "Beyond Adaptation: Resilience For Business In Light Of Climate Change And Weather Extremes," *Business & Society* (49:3), Pp. 477–511.
- London, M., And Smither, J. W. 2002. "Feedback Orientation, Feedback Culture, And The Longitudinal Performance Management Process," *Human Resource Management Review* (12:1), Pp. 81–100.

- Madill, A., Jordan, A., And Shirley, C. 2000. "Objectivity And Reliability In Qualitative Analysis: Realist, Contextualist And Radical Constructionist Epistemologies," *British Journal Of Psychology* (91:1), Pp. 1–20.
- Mallak, L. A. 1999. "Toward A Theory Of Organizational Resilience," In *Portland International Conference On Management Of Engineering And Technology*, Portland, OR, USA. 25-29 July, P. 223.
- Markus, M. L. 1983. "Power, Politics, And MIS Implementation," *Communications Of The ACM* (26:6), Pp. 430–444.
- Martin, R. 2012. "Regional Economic Resilience, Hysteresis And Recessionary Shocks," *Journal Of Economic Geography* (12:1), Pp. 1–32.
- Mccann, J., Selsky, J., And Lee, J. 2009. "Building Agility, Resilience And Performance In Turbulent Environments," *People & Strategy* (32:3), Pp. 44–51.
- Mcmanus, S., Seville, E., Vargo, J., And Brunson, D. 2008. "Facilitated Process For Improving Organizational Resilience," *Natural Hazards Review* (9:2), Pp. 81–90.
- Meiklejohn, S., Pomarole, M., Jordan, G., Levchenko, K., McCoy, D., Voelker, G. M., And Savage, S. 2013. "A Fistful Of Bitcoins: Characterizing Payments Among Men With No Names," In *IMC '13 Proceedings Of The 2013 Conference On Internet Measurement Conference*, K. Papagiannaki, K. Gummadi And C. Partridge (Eds.), Barcelona, Spain, Pp. 127–140.
- Mendonça, D. 2007. "Decision Support For Improvisation In Response To Extreme Events: Learning From The Response To The 2001 World Trade Center Attack," *Decision Support Systems* (43:3), Pp. 952–967.
- Milanzo, D., And Weeks, R. 2014. "Understanding Servitization: A Resilience Perspective," In *Portland International Conference On Management Of Engineering & Technology (PICMET)*, D. F. Kocaoglu (Ed.), Kanazawa, Japan. 27-31 July, Pp. 2332–2342.
- Mosakowski, E. 1998. "Entrepreneurial Resources, Organizational Choices, And Competitive Outcomes," *Organization Science* (9:6), Pp. 625–643.
- Mousavi, P., Marjanovic, O., And Hallikainen, P. 2012. "Disaster Recovery – The Process Management Perspective," In *Proceedings Of Pacific Asia Conference On Information Systems (PACIS)*, Pp. Paper 67.
- Nakamoto, S. 2008. *A Peer-To-Peer Electronic Cash System*. <https://Bitcoin.Org/Bitcoin.Pdf>. Accessed 20 February 2015.
- Pal, R., Torstensson, H., And Mattila, H. 2014. "Antecedents Of Organizational Resilience In Economic Crises—An Empirical Study Of Swedish Textile And Clothing Smes," *International Journal Of Production Economics* (147), Pp. 410–428.
- Ponomarov, S. Y., And Holcomb, M. C. 2009. "Understanding The Concept Of Supply Chain Resilience," *The International Journal Of Logistics Management* (20:1), Pp. 124–143.
- Rice, P. L., And Ezzy, D. 1999. *Qualitative Research Methods: A Health Focus*, South Melbourne, Australia: Oxford University Press.
- Sarasvathy, S. D. 2001. "Causation And Effectuation: Toward A Theoretical Shift From Economic Inevitability To Entrepreneurial Contingency," *Academy Of Management Review* (26:2), Pp. 243–263.
- Seville, E. 2008. "Resilience: Great Concept But What Does It Mean?" Council On Competitiveness - Risk Intelligence And Resilience Workshop, Wilmington, USA.
- Shane, S. 2000. "Prior Knowledge And The Discovery Of Entrepreneurial Opportunities," *Organization Science* (11:4), Pp. 448–469.
- Shane, S., And Venkataraman, S. 2000. "The Promise Of Entrepreneurship As A Field Of Research," *Academy Of Management Review* (25:1), Pp. 217–226.
- Shane, S. 2003. *A General Theory Of Entrepreneurship: The Individual-Opportunity Nexus*, Cheltenham, UK: E. Elgar.

- Sheffi, Y., And Rice, J. B. 2005. "A Supply Chain View Of The Resilient Enterprise," *MIT Sloan Management Review* (471), Pp. 41–48.
- Sheffi, Y. 2005. *The Resilient Enterprise: Overcoming Vulnerability For Competitive Advantage*, Cambridge, Mass: MIT Press.
- Simmie, J., And Martin, R. 2010. "The Economic Resilience Of Regions: Towards An Evolutionary Approach," *Cambridge Journal Of Regions, Economy And Society* (3:1), Pp. 27–43.
- Sine, W. D., Mitsuhashi, H., And Kirsch, D. A. 2006. "Revisiting Burns And Stalker: Formal Structure And New Venture Performance In Emerging Economic Sectors," *Academy Of Management Journal* (49:1), Pp. 121–132.
- Smith, D., And Fischbacher, M. 2009. "The Changing Nature Of Risk And Risk Management: The Challenge Of Borders, Uncertainty And Resilience," *Risk Management* (11:1), Pp. 1–12.
- Stahl, B. C. 2014. "Interpretive Accounts And Fairy Tales: A Critical Polemic Against The Empiricist Bias In Interpretive IS Research," *European Journal Of Information Systems* (23:1), Pp. 1–11.
- Starr, R., Newfrock, J., And Delurey, M. 2003. "Enterprise Resilience: Managing Risk In The Networked Economy," *Strategy+Business* (30), Pp. 1–10.
- Steyaert, C. 2007. "'Entrepreneurship' As A Conceptual Attractor? A Review Of Process Theories In 20 Years Of Entrepreneurship Studies," *Entrepreneurship & Regional Development* (19:6), Pp. 453–477.
- Strauss, A. L., And Corbin, J. M. 1994. "Grounded Theory Methodology," In *Handbook Of Qualitative Research*, N. K. Denzin And Y. S. Lincoln (Eds.), Thousand Oaks: Sage Publications, Pp. 273–285.
- Sullivan-Taylor, B., And Branicki, L. 2011. "Creating Resilient Smes: Why One Size Might Not Fit All," *International Journal Of Production Research* (49:18), Pp. 5565–5579.
- Tierney, K. J., And Bruneau, M. 2007. "Conceptualizing And Measuring Resilience - A Key To Disaster Loss Reduction," *TR News* (250), Pp. 14–18.
- Tzabbar, D., Aharonson, B. S., Amburgey, T. L., And Al-Laham, A. 2008. "When Is The Whole Bigger Than The Sum Of Its Parts? Bundling Knowledge Stocks For Innovative Success," *Strategic Organization* (6:4), Pp. 375–406.
- Vaast, E., And Walsham, G. 2011. "Grounded Theorizing For Electronically Mediated Social Contexts," *European Journal Of Information Systems* (22:1), Pp. 9–25.
- Vigna, P. 2014. *5 Things About The Mt Gox Crisis*. [Http://blogs.wsj.com/Briefly/2014/02/25/5-Things-About-Mt-Goxs-Crisis](http://blogs.wsj.com/Briefly/2014/02/25/5-Things-About-Mt-Goxs-Crisis). Accessed 30 April 2015.
- Vogus, T. J., And Sutcliffe, K. M. 2007. "Organizational Resilience: Towards A Theory And Research Agenda," In *ISIC. IEEE International Conference On : Systems, Man And Cybernetics, 2007.*, Pp. 3418–3422.
- Walker, B., Holling, C. S., Carpenter, S., And Kinzig, A. 2004. "Resilience, Adaptability And Transformability In Social–Ecological Systems," *Ecology And Society* (9:2), Pp. 1–9.
- Walker, J., And Cooper, M. 2011. "Genealogies Of Resilience: From Systems Ecology To The Political Economy Of Crisis Adaptation," *Security Dialogue* (42:2), Pp. 143–160.
- Weick, K. E. 1988. "Enacted Sensemaking In Crisis Situations," *Journal Of Management Studies* (25:4), Pp. 305–317.
- Williams, N., Vorley, T., And Ketikidis, P. H. 2013. "Economic Resilience And Entrepreneurship: A Case Study Of The Thessaloniki City Region," *Local Economy* (28:4), Pp. 399–415.

- Woods, D. D. 2006. "Essential Characteristics Of Resilience," In *Resilience Engineering: Concepts And Precepts*, E. Hollnagel, D. D. Woods And N. Leveson (Eds.), Aldershot, England, Burlington, VT: Ashgate, Pp. 21–34.
- Yetis-Larsson, Z., Teigland, R., And Dovbysh, O. 2014. "Networked Entrepreneurs: How Entrepreneurs Leverage Open Source Software Communities," *American Behavioral Scientist* (59:4), Pp. 475–491.
- Yin, R. K. 1981. "The Case Study Crisis: Some Answers," *Administrative Science Quarterly* (26:1), Pp. 58–65.
- Yin, R. K. 2009. *Case Study Research: Design And Methods*, Los Angeles: Sage Publications.
- Zhang, W. J., And Lin, Y. 2010. "On The Principle Of Design Of Resilient Systems – Application To Enterprise Information Systems," *Enterprise Information Systems* (4:2), Pp. 99–110.