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Exploring technological instantiation of regulatory practices in entangled financial markets

Wendy Currie, Audencia Business School
Jonathan JM Seddon, Audencia Business School

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EXPLORING TECHNOLOGICAL INSTANTIATION OF REGULATORY PRACTICES IN ENTANGLED FINANCIAL MARKETS

Introduction

The Great Recession of 2008 (Verick and Islam, 2010) precipitated significant change across financial markets where new and revised regulatory and compliance regimes were deployed to mitigate the risk of further financial meltdown. Financial technology plays an increasing part in this process, as regulators, policy-makers, financial organizations and vendors, instantiate information technology across an international financial ecosystem (Butler, 2017; Schinckus, 2018, Drummer et al, 2018). Within financial markets, technologies are developed and adapted to fit work practices, which may also change as a result of technological intervention (MacKenzie and Wajcman, 1999). Three decades ago, Granovetter (1985, 909) observed technology was ‘taken as given’ by participants interacting across geographical domains and time zones. Since the 1980s, such development has accelerated with an increase in ‘orders of magnitude’ through worldwide inter-connectedness (Sassen, 2001). Technologies used in regulatory compliance provide a relevant example, as they shape and adapt to meet changing policy and legal requirements imposed on global financial markets (Williams, 2013). Despite the growing importance of financial technology, combined literatures on institutional theory (Munir, 2011) and the social studies of finance (Knorr-Cetina and Preda, 2012) have so far under-researched the ‘back office infrastructure of trading’ (Mackenzie, 2009, 45) as relevant theoretical and empirical areas for research enquiry. Combining institutional theory with financial sociology, this paper theorizes technology within financial fields and across networks of agents to guide empirical enquiry on the *technological instantiation of regulatory practices in financial markets*.

First, innovation in financial services is fuelled by relentless technological change, often referred to as ‘digitization’. Complex technological infrastructure and applications introduced in numerous financial processes, products and services have revolutionized trading floors around the world (MacKenzie, 2009). As an institutional field, financial markets are temporal and spatial domains comprising organizations and individuals where material and symbolic acts are constructed across multiple levels of analysis (Friedland and Alford, 1991, 242). Second, financial markets comprise digital networks designed to maximise the outcome of global market interactions where simultaneous interconnected flows and transactions enable decentralized access for fund managers, traders and individual investors (Fligstein, 1990; Knorr-Cetina and Preda, 2007). Third, finance involves transactions between agents who control the flows of money, and where the material properties of digital networks are infused with cultural and symbolic meaning (Sassen, 2005). Global interconnectivity of financial markets, deregulation, high speed networks and increased access enhance the number of orders, the length of market chains (i.e. distance between instrument and underlying asset) and the trading decisions of market participants.

To understand technological instantiation of regulatory practices in financial markets, concepts of field (Bourdieu, 1977), networks (Podolny, 2001), performativity (Callon, 2007), agencement (Callon and Caliskan, 2005), and financial market entropy (Blinder, 2016) guide our empirical enquiry on the deployment of financial technology in eight investment management firms based in the City of London, UK. The structural-agency divide frames how financial regulators seek to impose stringent rules and penalties to prevent economic agents, such as fund managers and traders, from circumventing these rules in their day-to-day trading activities. Technological instantiation of regulatory practices plays an important part in this endeavour, as financial firms use technology to enhance transparency, but also as a tool to conceal algorithmic trading decisions (Danaher, 2016). Building on selected concepts and empirical data, our theoretical contribution aligns institutional theory with financial market scholarship. Here, we empirically apply concepts of field entanglement and financial

market entropy to illustrate how technological performativity and agencement co-exist. We observe the complex, inter-related global financial ecosystem which oscillates between relative stability with over-regulation and instability, as regulatory rules become compromised over time (Aizenman, 2011). Our paper encourages more multi-paradigmatic work in management research which situates financial regulation and technology in the context of wider debates on financialization (Epstein, 2005; Krippner, 2005). This work shows how financial innovation influences regulatory practice which, in turn, spawns further financial innovation in modern industrialized economies.

A Brief History of Financial Regulation

Financial regulation is part of the historical narrative of global economies undergoing almost constant change as a response to disruptive events. An observation of the past century shows periods where policy-makers called for deregulation or re-regulation. While exogenous shocks (Epstein, 2005; Fligstein, 2001) give way to serious financial crises, the precursor to each of these events is characterized by different inter-connected institutional and organizational field dynamics. The Wall Street Crash of October 1929, shocked by the London Stock Exchange crash the previous month, illustrates inter-connectivity of financial markets (White, 1990). An example of regulatory change is the Banking Act (1933), also known as the Glass-Steagall Act. Intended to return confidence to the financial system, the initiative focused upon averting disruptive financial market events. The act separated commercial and investment banking to prevent banks from making risky investments on the stock market using depositors' funds (seen as a contributing cause to the Wall Street crash) (Funk and Hirschman, 2014). This structure began to change at the end of the World War II, when banking operations moved away from the tightly regulated niches that were created in the 1930s to retail focused financial services competition (Fligstein, 1990; Useem, 1996). In 1999 the act was repealed by the Gramm-Leach-Bliley Act, arguing that allowing banks to diversify would reduce risk. In Europe, seven banking directives were replaced by a single Banking Directive in 2000, again, to improve transparency.

The purpose of the Undertakings for Collective Investment in Transferable Securities directive (UCITS I), released in 1985, was to standardise EU regulations for open-ended transferable securities between every EU member state. Intended to simplify trading, differing marketing rules created obstacles that weakened its impact. The deregulation of the UK banking sector in the mid-1980s encouraged a more US-style business culture with financial technology playing a large part in business operations. Technology-enabled financial trading constantly provides new opportunities for banks to expand their global activities. As banks have expanded, concerns have grown about the 'too big to fail' phenomenon in parallel with regulators' constantly playing *catch-up* with new regulatory mandates to prevent financial malfeasance (Sorkin, 2010).

UCITS II was developed in the early 1990s, and abandoned because agreement between EU policy-makers could not be reached. An initiative in the form of the Investment Services Directive as part of the Financial Services Action Plan (FSAP) was enacted in 1996. This established the framework that enabled banks and investment firms to provide services to other EU member states, making the European market much more integrated. When the EU commission finally agreed on changes to UCITS III in 2001, it included a much wider range of instruments, including derivatives.

The financial scandals surrounding shareholder losses at Enron (\$74bn) and Worldcom (\$180bn) contributed to the Sarbanes Oxley Act of 2002. At the time it represented the most sweeping set of business regulations since the Securities and Exchange Act of 1933, and applied to any country that held securities registered or listed in the US. The appetite to increase governance, regulation and compliance, was stepped up following the financial collapse of the dot-coms post 2002, which fuelled the need for financial firms to invest heavily in compliance activities, with many large firms obliged to spend millions of dollars (Leuz, 2007; Currie et al, 2018).

Successive financial regulatory approaches emphasise different priorities, often arising from past events in financial markets and firms. For example, unlike Basel I (1998) which did not differentiate risk (and perversely encouraged risk seeking on credit) the Basel II Accord of 2004 proposed recommendations on how much capital banks needed to put aside to offset their lending and investing practices. It also promoted loan securitization, a key part of the sub-prime market that was at the heart of the Great Recession. Between 2004 and 2008 the SEC began a voluntary programme for five of its largest investment bank conglomerates (Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch, and, Morgan Stanley). This Consolidated Supervised Entities (CSE) program was intended to fill the gap created by repealing the Gramm-Leach-Bliley Act, because the SEC was unable to demand that these companies reported on their capital, liquidity or leverage. The CSE's failure was because voluntary supervision weakened its perceived effectiveness (Cox, 2008).

Within the context of deregulation and re-regulation, attempts to streamline the differing laws on market abuse (such as insider trading) were addressed in the 2005 Market Abuse Directive (MAD I). The objective was to create a level playing field between the EU member states and to foster cross-border cooperation. The first

European regulation that focused on the market risk presented by credit institutions and investment firms was the Capital Adequacy Directive (CAD I) of 1993, updated in 1998 (CAD II) allowing banks to use their own capital adequacy estimates using value-at-risk (VaR) techniques. In 2006 it became the Capital Requirements Directive (CRD I), and included Basel II guidelines. Yet the most significant piece of legislation introduced by the FSAP is the 2007 Markets in Financial Instruments Directive (MiFID I) which looked at the competitiveness, efficiency and integrity across EU Member States. It is regarded as the cornerstone of EU regulation of the financial markets (FCA, 2014).

Two primary forms of financial regulation have been adopted: principles based; and rules-based. Principles-based regulation emerged in the pre-crisis period as a form of self-regulation by giving industry participants the power and latitude to set high-level regulatory goals and outcomes (Ford, 2010). Following the Great Recession regulators came under serious pressure to introduce a rules-based form of regulatory surveillance to tighten up on “loophole behavior.” Seen as complementary approaches, the UK Banking Standards Review Council developed “a single principles-based code of practice in alignment with the high-level principles now being considered by the regulators” (Lampert, 2014, p4). The UK regulators’ ‘Principles of Business’ (FCA, 2020) was designed to change the culture and behaviour of individuals. Breaching the principles of the ever-evolving single market directive (which as of 2020 included CAD, Solvency II, MiFID, IDD, MCD, UCITS, and AIFMD) (see Appendix Table A1) would result in rules-based sanctions and fines for non-compliance.

Theoretical Context

The institutional theory literature has a long tradition of focusing on stable and resilient aspects of material and social structures. Much work considers the effects and processes by which systems, rules, myths, norms, and routines, are created, diffused, adopted, and adapted over space and time (Scott, 2008). Contributions from institutional theory explain how these elements undergo change and fall into decline, becoming deinstitutionalized and replaced by new institutional governance structures (Oliver, 1992). The complexity of political, regulatory and technological change provides the content for theoretical and empirical work within neo-institutionalism (Greenwood and Hinings, 1996). Practice-driven institutional work examines change that originates in the everyday activities of individuals which result in shifts in field-level logics (Lounsbury, 2007). To date, few empirical studies examine working practices combining regulation and information technology using multiple levels and units of analysis. Instead a large body of institutional scholarship examines the micro-processes of field production at the organizational level (Smets et al, 2012).

Combining institutional literature with theoretical perspectives from the sociology of financial markets (Knorr-Cetina and Preda, 2004; 2012), or new economic sociology (Fourcade, 2007), we position financial technology in the wider context of financial regulation. Financial markets are viewed as formal and mechanistic systems. Rational (economic-man) models ‘perform the market’ (MacKenzie and Millo, 2003), and socio-technical systems observe economic agents displaying routines and habits that contribute to market stability, or create conditions for instability (Calvo and Mendoza, 2000).

From this body of work, we use five concepts to analyse financial markets: *fields*; *networks*; *performativity*; *agencement*; and *entropy*. The first views financial markets as institutionalized fields with specific contributions on the financial services industry (Fligstein 1990; Fligstein and McAdam 2012). Financial markets theorized as *fields* and *sub-fields* combine multiple, inter-related institutions with agents adopting various *positions* or *stakes* (Bourdieu 1977).

The second considers economic action and social structure as a *network of relationships* (Knorr-Cetina and Preda, 2007). Contrasting economic agents as under-socialized or over-socialized, a more insightful analysis views economic rationality as ‘embedded’ in social relationships. In the context of financial regulation, networks of social relations between people are no guarantee of ‘an orderly self-regulating system’, and ‘social networks alone will not deter malfeasance’ (Granovetter, 1985).

The third introduces concepts of *performativity* asserting that economics does not simply describe economic phenomena; it also produces the phenomena it analyses (Callon, 1998) influencing practices, society and political processes (Cochoy et al., 2010). The fourth is *agencement* denoting socio-technical arrangements for their capacity to act and to give meaning to action (Callon and Caliskan, 2005). Whilst performativity is closely related to economics by focusing on how agents perform the market, agencement expands socio-technical explanations to include a wider array of phenomena including (but not limited to) tools, equipment, technical devices and algorithms (Callon, 2005).

The final concept is *entropy* - a term originating from thermodynamics and later applied to financial markets (Zhou et al, 2013). It is a measure of the disorder of the energy of a collection of particles where things become more disorganized in a process of entropy as time goes on. We conceptualize entropy within financial markets as

high or low. A metaphor is the sand pile and sand castle. The sand pile exemplifies high entropy, and the sand castle low entropy. High entropy is where the sand pile is arranged or ordered in many different ways without disturbing its structure and composition of particles. Low entropy is where the sand castle is ordered in a way that it is vulnerable to becoming disordered. We conceptualize financial market entropy moves from low to high entropy (and back again) as regulators try to bring order to financial markets. So following a cycle of financial turbulence (Dagher, 2018), regulators impose new regulations, often with mixed and unintended outcomes (Wah Hlaing and Kakinaka, 2018).

Institutional theory and financial sociology share a tendency to ‘black-box’ technology. Material and social properties of technology are seldom unpacked or articulated in a professional or practical context. Writers observe studies emphasise how regulatory regimes *impact* financial innovation (products and services) but fail to look at this relationship in the opposite direction (Funk and Hirschman, 2014). This research is motivated to examine how financial technology is used to instantiate regulatory regimes, as a material artefact with an increasing role in financial regulation, and as a social phenomenon, that shapes human action and behavior. We present our conceptual model in the next section.

Technology and Regulation in Financial Markets

There are a few examples of how technology instantiates regulatory practices in financial markets. One study shows how internal standards built into SWIFT, the messaging network originally designed to reduce payment errors between banks, dominated the financial services infrastructure by “creeping global governance” (Scott and Zachariadis, 2012, 2014). Another showed increased regulation to support market fragmentation impacted IT trading systems (Clemons and Weber, 1996). Alongside technical innovation in the evolution of financial markets (Millo et al., 2005, 243) financial regulation has gained increased scholarly attention in management research (Currie et al, 2018).

In 1998 the SEC introduced Regulation of Exchanges and Alternative Trading Systems (SEC, 1998) as a response to the rapid growth of electronic communication networks (ECN); computers that automatically match orders away from the traditional stock exchanges. In 2005 the SEC introduced Regulation NMS (SEC, 2005), twenty years after it had mandated to do so. Whilst this was “...to facilitate the establishment of a national clearance and settlement system for securities transactions” (SEC, 2004) this act fully opened the door to a market dominated by computer driven automation and High Frequency Trading (MacKenzie, 2018). Within a few years new types of financial shocks occurred and automation was seen as the cause (Van Vliet et al, 2013; Currie and Seddon, 2017). In 2010 the NYSE was temporarily stopped following a trillion dollar ‘flash crash’ when security prices collapsed because of high volume automated sells. The cause was a new event causing unexpected system behaviour, not anticipated by the software developers. Software bugs and glitches have caused stock market failures, including the IPO for the BATS exchange’s own shares; trying to launch a market making program on the NYSE; and the daily illiquidity contagions found between securities (Lauer, 2012; Giovanni and Foucault, 2014). On the February 3 2015, the SEC introduced Regulation Systems Compliance and Integrity (SEC, 2015), focusing on system integrity, resilience, availability and security. Once again, the use of technology required more rules.

Whilst there are many studies on regulation and financial innovation, the focus of this paper is how regulation influences processes through which new products, services and organizational forms are created and introduced, rather than how innovation shapes regulation (Funk and Hirschman, 2014). We combine ideas from institutional theory, the sociology of finance and finance. Technological instantiation of financial regulation illustrates relationships among *fields, networks, performativity and agency*. Over time (years) their cyclical influence on *financial market entropy* changes its state from low to high and back again (Figure 1).

Insert Figure 1 here

Financial organizations exist within *fields and sub-fields* which are mutually dependent, often characterized by conflicted and contradictory logics (Scott et al., 2000). Ring-fencing them as an isolated unit of analysis positions the wider society as either an abstract environment or an inter-organizational field (Friedland and Alford, 1991). This is a missed opportunity for social science researchers as societal (or state) policies, such as legal and regulatory mandates, extend beyond narrow organizational or technical imperatives (i.e. increased rules and surveillance on financial organizations) (Siering et al, 2017) to wider field events (i.e. interconnected financial market events, e.g. flash crashes). Institutional theory cautions against the dominant tendency in organization theory to isolate organizations from their institutional and social contexts, since they are rooted in existing and evolving policy-making agendas of elites, including politicians and financial executives. How these elites intervene to change the financial industry for better (or worse), through regulatory technologies of ‘coercion and control’, and how this process is shaped by symbolic and cultural factors, becomes important both theoretically and empirically (DiMaggio and Powell, 1983). Institutional fields are simultaneously material and idealized, systems of signs and symbols and rational and trans-rational (Friedland and Alford, 1991, 243).

While the concept of field provides a lens to understand the institutional and organizational parameters and interests within financial markets, *relational networks* are explicitly found. Financial markets have grown together with the development of inter-connected technical infrastructure and software as their material form (Mackenzie, 2009) and social networks of relationships between market participants (i.e. fund managers and traders).

Financial sociology looks at how technology is designed, implemented and used by traders (Knorr-Cetina and Bruegger 2002; Zaloom 2003; De Goede 2005, Preda, 2006). Technology has its own *agencement* and ability to exert both constraining and constitutive effects, co-existing with human actors in socio-technical networks. Markets are viewed as technological arrangements composed of artefacts and formulae which project their own paths of action to create a ‘calculative agency’ (Callon and Muniesa 2005). Many studies consider financial models enacted through technology to *perform* economic activity (MacKenzie and Millo, 2003; MacKenzie 2006). Technology in this context includes algorithms, visualization tools, and databases which facilitate transactions and interaction across *field, networks* and *agents*. It forms part of the technological materiality that constructs markets for the purposes of regulatory consumption through the actions it affords and the controls it applies (Millo and MacKenzie 2009; Williams 2013). *Performativity* determines the influence of technology on practices, such as algorithmic trading or financial transactions (Callon 2004; Preda 2007a, 2007b).

The overarching state for these four events is financial market entropy. We theorize entropy as a measure of risk used by financial analysts to represent the current behaviour of the market: the greater the risk the higher the entropy value (Sheraz et al., 2014). Following periods of crisis (e.g. the Great Recession) or scandal (e.g. Enron) an over-regulated market is created to restore consumer faith and confidence, measured by low entropy. Over time the effectiveness of regulation is weakened, due to a multiplicity of factors such as regulatory and legislative changes, or industry workarounds (Blinder, 2014; Menand, 2017). As entropy increases, so too does the chances of another financial disaster, and the need for increased regulation. Over time, the metaphorical pile of sand is built into a new sand castle.

Combining concepts of *field* and *networks, performativity, agencement* and *entropy* raise awareness about the lack of a theory of utility within economics which adopts a narrow view of individuals in terms of how the market constructs them, and how the market enables them to constitute themselves. We defer to political sociology which views individuals, organizations and society as equally important units of analysis. While methodological difficulties arise from embracing a multi-level analysis (Friedland and Alford, 1991) we believe it is crucial for gaining a rich picture of how financial firms use technology, not only to *perform* the markets, but also how socio-technical arrangements or *agencements* provide the capacity (for agents) to act and to give meaning to their actions. We therefore go beyond the ‘two stage model of diffusion’ which focuses upon the effects and processes of institutionalization and isomorphism, to include fields, networks and financial market entropy which operate in fragmented and contested conditions (Lounsbury, 2007; Schneiberg and Soule, 2005; Schneiberg, 2007).

As a global institutional system, the financial industry is complex and dynamic. This is reflected in the design, interpretation and application of regulatory mandates. Methodological individualism, with the focus on economic agents, provides insights by observing their actions and behavior (an example in the financial losses incurred by ‘rogue traders’ through dishonest activities). Yet theorizing that situates the individual or organization at the forefront of empirical enquiry may not produce nuanced explanations of social life, if the state is viewed simply as an ‘omnipresent’ and ‘disembodied power’ with elites imposing coercive rules and regulations on less powerful institutions and individuals (Powell and Colyvas, 2008). Financial regulators, while appearing to have significant powers to impose policy decisions on financial institutions and organizations, may find their access to material resources is no greater than those they wish to regulate. An example is information asymmetry with regulators finding their request for data/information is resisted by financial firms.

Similarly, the tendency to overstate the role of collective agency, treating supra-individual structures as non-observable reifications, with individuals viewed as ‘passive recipients of state power’, may also produce biased accounts. The analytical domain on individual agency and organization, may lead to an under-theorizing of the emergent properties of societal and inter-institutional effects or processes resulting in distorted and misleading results. The literature contains economic accounts that understate behavioral variation among different agents and social-technical accounts that overstate the strategic choices of agents. In sum, conceptual models need to specify the micro-social and cultural systems of macro-structures, and vice versa (Smets et al, 2012).

Our multi-level model which embeds our working concepts of field, networks, performativity, agencement and financial market entropy provides a starting point to examine an important research question in financial markets:

How does financial technology instantiate regulatory and legal mandates/regimes using coded rules embedded in automated trading platforms?

Research Method

The study benefited from the generous research access given to the authors at eight UK-based investment management firms. The organizations were all clients of a leading software vendor, headquartered in the USA. The motivation for the study emerged from mutual (researcher-client) interest in how financial technology has become integral to fund management and trading practices in the increasingly regulated financial industry, and from prior work from institutional theory and financial sociology on regulatory and technology in the years following the global financial crisis (Williams, 2013).

The pervasive ‘financialization’ of global economies (Epstein, 2005) is relevant for management scholarship on the intersection between financial regulation and technology. In carrying out this study, it was not our intention to present technology as a causal mechanism of the 2008 financial crisis. Rather, we were interested to gain a deeper understanding of how financial technology instantiates regulatory oversight with a view to building theory from context-specific empirical case studies (Eisenhardt, 1989; Silverman, 2013).

Data Collection

The study uses two methods of data collection. Primary data included interviews with a range of professional, managerial and technical informants based in London and the US. Secondary data sourced published material on the financial industry. Empirical data collection spanned a six months period (September 2014-March 2015). Our primary objective was not to compare and contrast the instantiation of financial technology in trading practices across investment management organizations, but to observe different material and social arrangements in the wider institutional context of emerging policies and rules for legal and regulatory compliance in the jurisdictions of Europe and the US. Table 1 presents reference data on each of the eight investment management firms (as of 2015) including their initial production use of financial technology from the same vendor and the approximate number of compliance rules they must follow to fulfil their legal and regulatory obligations. Our sample firms were selected because they had used numerous versions of the software over at least a ten-year period.

Insert Table 1 here

Client interviews were designed to elicit insights from a wide range of senior (C level) informants and others, including fund managers, compliance officers, industry representatives on regulatory committees, IT managers and relationship management consultants. A total of 56 interviews were completed, with each lasting around 1 hour. Table A2 in the appendix breaks down the roles of those interviewed. Typically, interviewees were re-contacted during transcription and analysis in order to provide clarification on key issues.

We observed from arranging interviews with informants that many were engaged in several concurrent professional and advisory roles. For example, a ‘Head of Compliance’ could also be a ‘Government Compliance Committee Representative’, thus combining two roles: the first being responsible for meeting compliance rules at the organizational level, and the other serving as an expert on a government committee which designs and implements compliance policy. Initial interviews with informants, many of whom having over three decades of experience of working in the financial sector, pointed to the importance of understanding the historical context of how successive financial crises have led to more stringent rules and regulations where technology has simultaneously played a part in this process.

To provide a detailed account of the historical and institutional changes in the financial industry, we collected secondary data from government bodies (i.e. the Financial Conduct Authority), industry reports, company annual reports, websites, emails and sales and marketing literature from technology vendor and client sites. Material from financial and IT conferences and workshops further provided some relevant contributions particularly in regard to ex-post accounts of how and why the financial crisis occurred and how new technology plays both a surveillance and a complicit role in the working practices of fund managers and traders.

Data Analysis

A case study method was selected to provide context-dependent data (Flyvbjerg, 2006) from informants, all of whom are employed in the financial services industry. Their reflections and perceptions of their decision-making, experiences and working practices provide insights beyond ‘abstracted empiricism’ (Wright-Mills, 1959) that builds theory by isolating a minimal number of variables (MacIntyre, 1984). In selecting a case method to analyse our interview data, we recognize this approach is likely to extend rather than narrow the phenomena and variables under scrutiny. Case studies contain descriptions about the social world that are complex, holistic and sometimes politically motivated (Stake, 1978).

From our inductive, open-ended data analysis, we transcribed tape-recorded interviews and revised our theoretical and empirical themes from institutional theory and financial sociology. We re-read secondary source material on multi-jurisdictional regulatory mandates as it was apparent that financial markets were becoming increasingly intertwined. Moving back and forth between data, literature and theory helped to categorize raw

data into relevant themes, with the purpose of building, refining and applying our theoretical concepts (Silverman, 2013).

As a complex, inter-dependent and dynamic institutional field, we analysed the data using temporal and spatial lenses. The financial domain is a twenty-four hours international activity characterized by relational networks where traders across the globe access the latest stock price data and information. Apart from our meeting with an officer from the SEC, all interviews were carried out in the City of London. UK informants frequently referred to US regulatory policy and its implications for practice in Europe.

Each of the eight firms relies heavily on their technological infrastructure and applications, and are engaged in meeting stringent legal and regulatory mandates to avoid heavy financial and reputational penalties. Post-crisis interviews with these firms helped us to gain deep insights, not only about financial technology and its role in meeting the conditions of regulatory mandates, but also about the relevance of wider events and practices leading up to the Great Recession. Many of these debates and issues are discussed in the emerging financialization thesis (Epstein, 2005; Krippner, 2005) which offers theoretical and methodological directions for management scholarship.

Ring-fencing our empirical enquiry on the intersection between financial regulation and technology drawing from concepts from institutional theory and financial sociology, the case study is a step towards theory generalization (Campbell, 1975). Our research themes presented in the next section include abstract dimensions in relation to the regulatory landscape derived from literature and empirics. Underpinning their selection are key regulatory policies, events, issues and outcomes, invariably arising from ‘problematic circumstances’ (Stake, 1994, Alvesson and Sandberg, 2011) such as financial crises. The common thread is political expediency to develop technology to meet regulatory mandates in a constantly changing and dynamic financial system. Analysing these events, which may be situational, purposive and inter-related, using a qualitative case study, we encourage cross-fertilization of theoretical and methodological approaches in management and other disciplines. Data analysis is a narrative of events over three decades, coupled with primary and secondary data that ‘tells a story’ (Carter, 1993) of the growing importance of financial regulation and information technology. Responding to concerns of ‘bias’ in case research methods, including the selectivity of data collection and analysis, we make two points. First, we note the common misconceptions which suggest that case research is less rigorous than hypothetico-deductive methods. While subjectivism and bias towards verification afflicts all methods, the case method has its own rigor enabling researchers to *close in* on *real life* events and issues where they can reflect on their own views about phenomena and how it manifests in practice (Flyvbjerg, 2006, 19). Our own pre-conceived views as researchers were tested and changed as the research enquiry progressed. Interviews with respondents encouraged us to revisit some of our pre-conceived ideas and concepts and the empirical direction of the study. We adopted a ‘reflexive lens’ (Burawoy, 2003) to analyse common methodological dilemmas in the epistemology of qualitative research. While experiential accounts are sometimes dismissed as anecdotal evidence, scope, depth and consistency were achieved by discussing key concepts, constructs and terminology with each of the informants and triangulating the findings across primary and secondary data sources (Flick, 2006). We also explained some of our working concepts to informants, such as ‘performativity’ and ‘entropy’, and this helped generate more insightful responses.

Second, the multi-case approach enabled us to analyse the various ideas and evidence provided by informants. While using multiple sites is not perceived as more rigorous than a single site (Ragin, 1992) our choice of eight companies points to a ‘revolving door’ as many of our informants have previously worked in two or more of our sample companies. These individuals have built strong networks of relations across the industry where they are familiar with the business strategies and technologies across several firms. As they share detailed commercial knowledge about their own and others’ firms, they can provide detailed comments about regulatory and technology strategies at the intra- and inter-organizational levels. Our data analysis, conceptual and thematic content was strengthened when, with mutual consent, we discussed general (non-commercially sensitive) issues with several informants.

The Case Study

Financialization of global economies fuels debates in social sciences about how nation states regulate the financial sector and firms which operate across multiple legal and regulatory jurisdictions (Krippner, 2005). These are important questions for academic researchers, and not easily answered in any single empirical study. Our research contributes to the financialization thesis by situating financial technology at the centre of regulatory and compliance practices. We supplement historical content on multi-jurisdictional regulatory practices and events with our empirical data. The case study is presented as a narrative of how financial technology instantiates regulatory mandates organized around eight key concepts developed from our empirical data (see Table 2).

Insert Table 2 here

Deregulation to Re-regulation in the Financial Markets

In a plan to harmonise EU financial services, European banking consolidation began with the Financial Services Action Plan (1999). The imposition of new rules and mandates in a “one-size fits all” legislative package did not sit well with the diverse financial systems across US and EU jurisdictions. One senior compliance manager explained:

“Prior to and following the dot.com era, we operated in a climate of deregulated financial services. The financial services industry was relatively relaxed about the corporate failures of 2001-2003. But all this changed after the 2008 financial crisis. This sent politicians and regulators into a tail-spin as they rushed to re-regulate the financial industry, often with rushed legislation and mandates” (C#7 COM).

Within a relatively short time period, most interviewees had witnessed fundamental changes to the compliance rules that managed their industry, the comments made by one compliance manager that “*Regulators are now flipping from policies of de-regulating and over-regulating trading environments.*” (C#3 COM) was repeated by many. With less regulation, the greater the opportunity for profit as inefficiency creeps in. One fund manager commented:

“Key regulatory reforms reflect US and EU requirements. There was a view that efficient markets were negatively influenced by too much government regulation.” (C#7 FM)

This ‘influence’ reflected on how trading had been prior to the Great Recession. Such a view had the mirror opposite interpretation by a SEC compliance officer who said:

“The excessive use of derivatives was one of the roots of the 2008 crisis. So many new OTC products were devised and created and they were just inadequately regulated by the Commodities Futures Modernization Act.” (FSA#1 COM)

The ability to create and trade these unregulated instruments offered great profits but the risks were either not understood or simply ignored. The near collapse of Bear Sterns, default of Lehman Brothers, bailout of AIG and Royal Bank of Scotland created pressure for more intensive regulation of financial markets. As one fund manager officer said:

“We had to wait until 2012 before EU regulation was passed which increased the stability of how OTC’s were traded [EMIR]” (C#3 FM)

It wasn’t just the traded products that needed regulating. One fund manager pointed out that “*Post-financial crisis, there has been a lot of discussion about separating retail banking from the more risky casino-style banking*” (C#4 FM). Within a relatively short period, the financial industry had again changed from low to high regulation and control.

Shifts in the Regulatory Pendulum

Over past decades, there has a shift in the regulatory pendulum from one of deregulation to re-regulation against a background of successive periods of economic boom and bust. This complex system is an amalgam of

principles and rules -based approaches which reflect the psychological shifts in regulatory practices. This is reflected in the comments of an IT director:

“Now that co-regulation and self-regulation have given way to a more command and control approach, the fact that financial markets and technologies are moving so fast does not mean that regulators can easily identify ‘loophole behaviour.’” (C#5 IT)

Differences can be seen between how the regulators believe a rule should be defined and what the rule is attempting to measure, as highlighted by another compliance officer:

“There have been instances in which regulators have sought to reduce what the industry would view as normal levels of derivative usage in a given fund, based on their lack of understanding of gross leverage figures. AIFMD level 2 excluded the use of VaR as a regulatory risk measure in favour of the gross and commitment leverage method, which in my view constitutes a retrograde step.” (C#7 COM)

Having identified different requirements, questions on how securities would be tested were raised, as another compliance officer pointed out:

“More and more derivatives are being used by our alternative funds, but how will the vendor stay on top of this as newer types of instrument are being developed all of the time?” (C#6 FM)

Issues don't just exist with how a rule is interpreted, a more fundamental issue is being in a position to actually run the rule with the right data, as highlighted by another compliance officer:

“Data is our biggest problem. One example is how we measure securities ratings. If we don't have this then we will use the issuers rating instead. It's not what we should use, but this is better than simply ignoring the rule.” (C#1 COM)

So not only are the new rules problematic, enforcement is also inconsistent as illustrated by one fund manager's comment:

“US regulators are more aggressive than their EU counterparts in litigating against rule-breakers.” (C#4 FM)

Investment is made to maximise returns, but if a regulatory breach has differing consequences, then this will have a significant impact on trading behaviour. Our informants did not see rules-based regulation replacing principles-based regulation, but as part of a continuum which shifted the emphasis to a more punitive and sanctions-based approach. As one Senior Compliance Manager explained,

“Rules-based regulation is a knee-jerk response to the financial crisis. We now have to interpret and introduce new rules into our financial systems. But the problem we face is that the regulator imposes sanctions if we get it wrong, but the rules are not clear. We sometimes feel in the dark here” (C#5 COM).

Entangled Financial Fields

We observe from our primary and secondary source data the financial field becoming more entangled, with questions arising about the effectiveness of financial regulators, such as the UK Financial Services Authority (FSA) (now the FCA) to regulate banks, insurance companies and mortgage businesses in the light of the financial scandals. Gordon Brown (2011), former UK Chancellor of the Exchequer, said when discussing the failure of the FSA:

“...We didn't understand just how entangled things were...we didn't understand the entanglements of different institutions...and we didn't understand just how global things were...” (Brown, 2011).

This was mirrored by the comments from a compliance officer:

“Trading networks are increasingly digital and the regulators are having trouble keeping up with national legislation, let alone multi-jurisdictional trading environments.” (C#6 COM)

The shift from deregulation to re-regulation of financial markets occurred in an environment of rapid globalization where technology enabled new product and service opportunities. Earlier financial scandals had forced the US to take action and the Sarbanes-Oxley act became a mandatory international rule book, as a compliance office explained:

“It was because of massive US corporate failures that we now have to apply the SOX rules [Sarbanes-Oxley Act 2002] to any US security that we hold here in Europe.” (C#1 COM)

The Dodd-Frank Wall Street Reform and Consumer Protection Act (DFA), approved in February 2010, was a 400-page document stipulating what heightened capital, liquidity, risk management, and stress testing requirements were urgently needed. And once again the US regulator was directly shaping EU activity:

“The US regulator had to restore confidence to the markets and the number of rules in Dodd-Frank has massively really increased our workload” (C#6 COM).

Simply assuming that rules from one country could just get applied to another is far too simplistic:

“We have to interpret supra-national and national regulatory mandates and the rules are confusing and not precise.” (C#2 COM)

As the interpretation of some rules is not precisely defined, the ability to *perform* compliance operations is made more difficult. Take, for example, ‘allocation fairness’. The head of compliance at one company said:

“How can the SEC know we are following a process? When we are monitoring allocation fairness it’s all in order history. But we need to then produce a report via a convoluted process on the orders life. Often an order is partially filled at one price, merged with another and traded at a different price. Sometimes new accounts get added or split off and so at what point did you not do a fair allocation?” (C#2 COM)

This same issue is commented upon by a compliance officer at another site:

“You get a rule that looks at a fair allocation, but you need to decide how this is meant to be interpreted. If we wanted to buy 100,000 shares but only fill 80,000, how do we allocate this across the order? Is it by their order size, by account size, how earlier allocations were done – it just goes on. And then there are additional factors such as the minimum order size or how much a client can hold. Once allocated, we have to make sure that Traders follow the same process every time.” (C#4 COM)

Neither company uses the same interpretation of the rule simply because each company has a different view on what is required. Operating within a global and interconnected economy brings additional issues that have simply not been considered, as explained by a fund manager:

“The financial institutions operate within a complex and inter-connected system which is made even more opaque by different regulatory and technological factors. Economic problems in one country such as, the US in 2008 and in the Eurozone more recently, can have a ‘knock-on’ effect throughout the global economy. This has become more acute in recent decades” (C#2 FM)

Relational Networks in Regulatory Jurisdictions

Our interviews point to close ties between regulators, senior managers and technology professionals, including software vendors. Relational networks reflect both a material and social dimension, where clients and vendors routinely discuss financial regulation and how technology can be developed in response to new mandates. Client conferences, user groups and forums are an integral part of how financial firms interact to discuss the diffusion of regulatory policies and also how technological infrastructure and applications support this process. A senior compliance officer commented:

“We have hosted compliance events open to all of the vendor’s clients. We provided a conference room that was used by the vendor to demonstrate their latest compliance

developments. We [the customers] all know that if we are ever going to get EU changes to comply with EU regulations in a US product, then we are going to have to club together and present a united front.” (C#1 COM)

It is interesting to note that the vendor was attempting to develop a system that was used globally but had its own development bandwidth limitations. The compliance officer at one company commented:

“What we find surprising is that we have to push the vendor to develop compliance rules that cover netting and hedging because these are core regulatory requirements.” (C#6 COM)

Whilst the IT director at the same company had had to write a database report which processed trade details because of other system gaps:

“We have a team that is used to monitor allocation fairness manually at the moment because our trading system is simply not good enough. When the vendor really starts to develop this, then we want to be involved.” (C#6 IT)

Relational networks were strengthened as financial professionals left one company to join another, usually by being headhunted by someone from the new company. A Head of Compliance said:

“If we are not sure on how to write a new mandate, for example one of the new UCITS regulations, then we will call other compliance officers that used to work here and share our ideas. Sometimes this is the only way of really digging in to what data is needed and how the rule can be coded.” (C#3 COM)

These informal relationships were similar among traders. The quote below is from the Head Trader sharing information about the financial technology used by both companies:

“I called the head trader at C# 3 to ask if they had the same issues that we have had when we try and trade. We missed the market because our system just crashed and the compliance team is now all over us. We are going to have to compensate out of our profit margin.” (C#1 TR)

One project manager discussed the importance of seeking advice about technology configuration from other project managers rather than the vendor:

“If we want to trade a product such as a fund of hedge funds, we ask other system users and not the vendor as they really don’t know how it works with the data issues that we

are facing. They [the vendor] work from a model where all the data is available and it's tested on dedicated systems. We run other software tools on our machines and this can sometimes kill the processing speed". (C#3 IT)

Our findings suggest a network effect was present as financial market participants developed relationships around regulatory compliance and financial technology. By entering into a constant dialogue, the value of these relationships strengthened: with better interpretation and implementation of regulatory mandates; brainstorming on how improvements could be made; and collective influence on the vendor. One comment by a fund manager underlined the increasing importance of technology:

"Technology has enabled so much interconnectivity where algorithmic trading can be done without human involvement. Relationships are now more between computers and less so between people." (C#6 FM)

Embedding Regulatory Practices and Rules

Relational networks across financial markets are manifested in material and social factors, where embedded regulatory practices and rules are a key feature of government and industry-wide policy. The provision of a robust, supranational regulatory body has been a long-term goal of the European Monetary Union (EMU) and the desire to create a single market between all the Member States is at the heart of all EU legislation. Not only is a European wide policy interpreted and applied at Member State level, but firms with business operations across national jurisdictions need to be aware of the national policies of each country. But embedding regulatory practices across national boundaries poses serious challenges for policy-makers and companies. The head of compliance at C#4 COM said:

"Our CCO has sent a letter to the FCA on why regulations on conflicts of interest are not done properly. This has always been a problem, even before the [2008] crisis."

Others directly criticised the regulator for acting more as 'accountants' and 'economists' rather than demonstrating an understanding of practitioner interests. A compliance officer gave one example of a 'disconnect' between regulation and investment checks:

"There have been instances in which regulators have sought to reduce what the industry would view as normal levels of derivative usage in a given fund, based on their lack of understanding of the precise importance of gross leverage figures. Look at AIFMD level 2 for an example. This excluded VaR as a risk measure in favour of gross and commitment method leverage, which in my view constitutes a retrograde step." (C#7 COM)

The comment below from another compliance officer also highlighted issues of interpretation:

"Fair allocation is the classic case of how a rule is open to interpretation. Order size, account size, when the account joined the order or how the prices have been aggregated

are all open to interpretation. Every company will have a different way of calculating what they mean by ‘fair’, and the trick is to make sure that you are consistent on how it gets applied.” (C#4 COM)

Recalling the different EU rules in the FSA’s single market directive, it is unsurprising that confusion occurs:

“The EU mandates have all been developed without any consultation between the regulators. Sure, they copy and re-use one another’s rules, but don’t seem to think about what they are doing. For example, one calculation in a UCITS rule is optional, whilst the same rule has become mandatory in an equivalent MiFID regulation.” (C#7 COM)

The interpretation of financial directives and laws became more complex as market participants worked across different countries, and so needed to embed EU-wide and national regulatory mandates. One company (C#6 COM) with compliance teams in the US, UK and Germany were all engaged in writing their own rules:

“The UK compliance team are regarded as the UCITS experts and were given overall responsibility for the compliance in this area. However it is the US who developed all of the Dodd-Frank rules and they sent them to the UK so we could add them to the system. The Quants team are in Germany and they are regarded as the experts on their rule sets.”

Another company (C#2 COM) accepted that they did not have all of the internal knowledge to write the US rules for mutual and close-end hedge funds:

“No one in compliance had 40 Act knowledge so we had to recruit another compliance officer just to satisfy these rules.”

Institutionalizing Inert Uniformity

From our empirical data and reading of secondary source government reports on financial regulation, institutionalizing *harmonized* regulatory mandates across the EU is a key policy objective; albeit difficult to achieve in practice. While coercive rules and sanctions are part of the regulatory policy agenda, normative pressures to build a *compliance culture* are also important. We observe isomorphic pressure for inert uniformity in the diffusion of regulatory mandates. Issues surrounding efforts to apply regulation was given by one compliance officer:

“Harmonization of financial practices across markets is what the regulators want, but multiple jurisdictions mean that expertise is siloed, not just at national level, but also regional level in some cases. This makes it more difficult to find common ground as even companies interpret compliance rules differently.” (C#2 COM)

Inter- and intra-organizational embedded agency instantiated by technology is used to constrain actions and behaviour of human agents. Interviews with informants pointed to strong industry collaboration between customers and suppliers, and also between customers in competitor firms.

“We had a problem with deciding how we would apply a swap rule, so I called company X and spoke with John [they met many years earlier at the client conference] and asked him what he had done.” (C#1 IT)

Technology vendors keen to promote their products engage their customers in discussions about how each one is using a product for regulatory oversight. This information is not treated as commercially confidential among clients, partly because financial technology is seen as a commodity tool rather than a competitive device:

“As more and more funds are using new types of derivatives – we are keen to see how new functionality is built into financial technology and find out exactly how this is used by our competitors. We discuss this openly at events and forums with colleagues (from other firms).” (C#7 IT)

The value of working with other competitors is perhaps best evidenced by one client who had had their anonymity written into their contract. Its IT director said:

“Look at the way a CDS [Credit Default Swap] worked. The product just didn’t support it, even though we had the vendor’s product manager flown across twice! I ended up speaking at the vendors global client conference to bolster support – so much for keeping the tools we used to ourselves.” (C#6 FM)

Companies also share information about how they engage with technology vendors. Financial technology is often used on a ‘pick n mix’ basis, where infrastructure and applications are used in one or more business processes:

“We are looking at new products and markets such as liability driven investment (LDI) and derivatives. The structure and compliance rules that we need to trade these products simply isn’t in our existing investment management system. We can’t run the risk of being fined by the regulator if we do this on anything but an electronic system, and we can’t wait for this to get developed. One of our competitors has advised us about the financial system they use, which has been quite helpful to us in making a decision.” (C#1 FM)

The close relationships formed between customers and technology vendors are an important element in shaping the strategic direction of financial technology. Isomorphic pressures are identified as clients play a part in directing the scarce development resources of the technology vendor to enhance the product or service for the universal adoption throughout the customer base.

Technological Performativity and Calculative Agency

Paradoxically, while we observe strong elements of institutional isomorphism through the embedded agency of market participants in working towards a regulator driven *culture of compliance*, our data illustrates examples of challenges to institutionalized structures as performative struggles emerge where calculative agents subjectively

interpret, implement and apply financial regulations to achieve their investment goals. Technological performativity, where regulators actively shape fund manager and trader decision choices, using embedded rules in software algorithms, may be resisted through *work-arounds* that result in circumventing these rules. Excel is a tool which allows software development to be quickly written by someone who is not a software engineer. Although the regulator does not instruct companies to invest in a specific technology, it seeks to apply coercive sanctions in the form of heavy fines on the continued use of spreadsheets to manage portfolios. This conflicted technological performativity was described by one fund manager:

“Our head of fixed income was sacked because he used Excel to manage his fund and had not shown correct due diligence. The fund was downgraded to ‘junk’ and there was a lot of pressure from the compliance team to sort the mess out. We were fined. Unless we had moved every debt fund, we would have been fined again because they insist that all trading occurs on a specialised system.” (C#6 FM)

A compliance officer questioned how any regulation would be possible if specialised systems were required to perform calculations:

“UCITS and AIFMD regulations have required risk departments to identify, isolate, measure and manage the various individual risk types to which funds are subject such as equity, fx [foreign exchange], interest rate, credit and volatility. They have now added a requirement to perform a range of stress testing, putting funds through scenarios such as an equity market collapse, the 2008 market illiquidity, etc. The only way this can be done is with another expensive tool such as RiskMetrics.” (C#7 COM).

Additional complexity is being layered into these regulations as each version is released in an attempt to keep up with the market changes. A senior compliance manager commented on the proposed solvency regulations:

“When we follow a solvency rule we need to manage exposures and generate numbers that are sourced from interest rate curves that have been feed into a risk system. This is totally deterministic and the numbers we generate are based on ex-post techniques.”
(C# COM3)

If a performative feature is built within the technology enabling each company to apply a rule consistently, the compliance condition is deemed to have been met, even if some variation exists in how companies reach the end state. One Senior Expert in VaR commented: *“CESR/10/788 has used the words ‘with the sole aim of’. This makes the purity of the portfolio manager’s intention a parameter for automated decisions. You will soon have to have to have a lawyer and a psychiatrist sitting next to you to determine your intent.” (C#7 COM)*

Another issue concerns the application of regulatory rules to existing financial products, where: *“It really is hard to net out derivatives so as to satisfy UCITS rules (C#2 COM).”* One compliance manager expressed concerns about rule valuation when the data used in a calculation is not robust:

“With one test we need to monitor the number of rating agencies for each security. If we have more than two then we use the mid value, if we only have two then use lowest value, and if we have no rating data then we look at the issuer rating. This means we are simply not looking at the right data for the rule.” (C#1 COM)

As algorithms were used to perform the regulatory process, the ‘data problems’ prevented running a clearly defined rule. But rather than ignore the rule, tests continued to be run, albeit with the wrong references. Another rule open to interpretation required a company to have checked on news articles before trading:

“There is a UCITS rule that requires us to check for news articles before a certain stock is traded. This is more of a box ticking process than having to follow any specific rule which tells us exactly what information sources we need to read or how often this needs to be done before we trade. It’s totally vague and I can’t see what it really offers.” (C#5 COM)

Our data shows that economic and social agents possess significant degrees of freedom to interpret and apply compliance rules. Whether a principles-based or rules-based approach is used, the regulator hopes to extend the compliance function as the ‘responsibility of everyone’ rather than just a check-box exercise which undermines the value of financial regulation. However, socio-technical agencement even when the interpretation is clear suggests the intentions of the regulator to increase reported levels of data may prove counterproductive. As regulators are keen to introduce supra-national regulatory mandates to harmonize financial regulation, the evidence from our data shows that technological performativity is inhibited by the limitations in the technology. This agencement of the technology vendor, which is embedded in the tools, equipment, technical devices and algorithms points to problems where some compliance rules were unable to be tested. A compliance manager said:

“I have given up asking the vendor when we will be able to run compliance tests for netting and hedging. What surprises me is that these are regulatory requirements, so why doesn’t the system cater for them now?” (C#5 COM)

Market Fragmentation and Instability

A fund manager, when commenting on the market fragmentation, stressed how computerization has had detrimental effects to the stability and structure of the market:

“Stability is always followed by periods of instability. Markets are becoming even more fragmented as computerization unleashes new opportunities to create even more complex financial products sold internationally, where the seller is unknown to the buyer. Take high frequency trading for example.” (C#1 FM)

Whilst the regulator looks to reduce information asymmetry by requesting more sophisticated and efficient ways to monitor and receive financial data, this is not matched by the opinions of those in the compliance function. A Senior Risk Officer commented:

“There are rules which seem to be written just because the computer exists. They now want the system to decompose risk measurements into their various sources of risk as well as a whole range of stress tests that would require a dedicated risk system. These calculations are truly beyond those of an order management system which can’t possibly have all of the historical data that it needs. Quite simply unless you have a risk system you are just not able to perform this test.” (C#7 COM)

Another informant, a Head of Compliance added:

“Some of the UCITS tests now expect us to run really difficult compliance checks, quite beyond any other test that we have seen before. The ‘cascade’ logic which it uses is the most complex that I have ever seen and we have had to go back to the vendor to ask them when they will update their software so these tests can be applied.” (C#4 COM)

While US and EU regulators develop and apply regulatory mandates to achieve greater alignment of multi-jurisdictional financial systems, this occurs in an environment of increasing fragmentation in relational networks across regulatory jurisdictions, as different countries (i.e., Member States) continue to ring-fence their financial markets and supervisory practices. A lack of adequate investor protection prevails where regulatory processes to manage instruments other than shares (i.e., derivatives and commodities) and systems required to provide price transparency or spread the benefits of reduced trading costs remain a work-in-progress.

A serious challenge to regulators is the proliferation of diverse and ‘exotic’ financial products. In September 2009, the G20 leaders met in Pittsburgh and made a commitment that by the end of 2012, derivative contracts will be to be traded in a similar regulated way as other instruments. The DFA stipulates that these products can only be traded on authorised venues. The European Market Infrastructure Regulation (EMIR), designed to increase the stability of the EU derivative market, is based on MiFID I. But the definition of the term ‘derivative’ is not widely shared, thus preventing its consistent application. To address the issue of fragmentation of directives and regulations, regulators have developed the next version of MiFID II and Markets in Financial Regulations (MiFIR). Such changes lead to this comment from a thirty-year veteran of regulatory compliance:

“The avalanche of new rules and regulations has seen the number of compliance officers grow by 70%. Financial regulation is a moving target. We have had MiFID I and II, and now MiFIR. Progress in making these regulations work is always slow because of the difficulty in getting agreement, not just in companies, but across countries. The US regulator mandates that rules passed in the US are also applied by countries trading on their exchanges. Internal lobbying and political battles mean that

getting European wide regulation takes much longer to get passed into law compared with the US". (FSA#1 COM)

Discussion

Regulators constantly define new laws and rules for the financial markets, which occupy a liminal space between relative stability and instability. The entanglement of the financial markets is a feature of the complex networks of relationships between institutions and organizations (Fligstein, 1990; Podolny, 2001, Davis, 2009). Our theorization of field entanglement within the global financial industry offers more clarity about the effects and processes of field-level change (Smets et al, 2012), not as isolated events or a linear process, but as conflicted and unpredictable social spaces (Bourdieu, 1977).

Field Entanglement and Entropy in Financial Markets

Successive financial and corporate crises have led politicians and regulators to seek effective ways to balance high entropy and low entropy. The sand pile (high entropy) depicts a system arranged and ordered in a variety of different ways where financial agents (fund managers and traders) have greater freedom to perform the market for profit maximization and personal gain. High entropy depicts an isomorphic state with a less regulated financial industry structure. The sand castle (low entropy) is a rigid structure where regulators build and impose stringent regulatory mandates to control the activities of institutions, firms and individuals. Here, low entropy shows the transition from deregulation to re-regulation, with pressures for inert uniformity intensifying following exogenous and endogenous shocks in financial markets.

Economic policies for free market financial services contribute to increased market fragmentation (Davis, 2009). Regulatory regimes simultaneously exert isomorphic pressures on institutions and organizations to reinforce best practice in compliance, while also routinely imposing new and potentially disruptive rules and mandates in highly differentiated, multi-jurisdictional regulatory environments. This shows a *paradox of embedded agency*, where organizational members' behaviors are constrained by institutions, simultaneously influencing and changing these institutions (Battilana, and D'Aunno, 2009; Walker et al, 2014).

In the period following the financial crisis, the re-regulation of the financial industry has seen the release of UCITS IV in 2009 to open up European markets to US fund operators. Controversially, this allows UCITS to be managed and supervised in a Member State other than its own, thus reducing national regulatory supervision and increasing operational risk (Hastings, 2009). In 2011 the EU protected investors by regulating the alternative fund managers rather than the funds themselves, via the Alternative Investment Fund Managers Directive (AIFMD). This put the assets of hedge funds and other alternative investment firms, valued at over \$3trillion, into a regulated framework (FCA, 2015). In a move to further reduce derivative risks around credit and operations, EMIR was introduced in 2012. This added additional technological requirements to trading, requiring reports submitted to repositories and these products cleared through a central counterparty.

Just as EU politicians impose regulatory directives across Member States to harmonize cross-national rules and laws and reduce market entropy, fragmentation increased as the US followed its own interests. Enacted by President Obama in 2010, we observe the re-emergence of re-regulation with the DFA. It contained 398 rules and represented the most sweeping changes in financial regulation since the Great Depression. But in 2018, (the now former) President Trump signed a new law which he said "*...rolls back the crippling Dodd-Frank regulations that are crushing community banks and credit unions nationwide...those rules just don't work....*" (Trump, 2018). These reversals were not in isolation. Over 50% of global trading occurs in the US, but an earlier executive order proposed to "*advance American interests in international financial regulatory negotiations and meetings*" as a core principle of the United States financial system (Trump, 2017). The Basel Accords are an international banking standard, but future versions such as Basel IV (due for implementation in 2023), are presented as anti-American and this may lead to separate US legislation.

Since the early part of the 20th century, attempts by government to impose regulatory mandates on financial markets have produced conflicted logics in either principles-based or rules-based policy initiatives. In the run-up to the financial crisis of 2008, our empirical data and literature review suggest that financial markets operated in an environment of deregulation, where market participants enjoyed greater freedoms to develop new financial innovations in the form of products and services (Funk and Hirschman, 2014). This changed following the crisis, with regulators across the jurisdictions stepping up their efforts to impose much tighter controls on the financial markets shifting the regulatory pendulum from principles to rules-based regulation (Black, 2008). Essentially regulators imposed tighter controls, despite these mandates becoming vulnerable to conflicted industry

responses. The most recent actions from the US looking to rollback DFA regulation and give their banks more control swings the pendulum back towards high entropy.

Our data shows financial technology is an important mediator in regulatory endeavours as technological infrastructure and applications promoted by regulators restrict financial agents' *gaming the markets*. Coercive, mimetic and normative institutional pressures (DiMaggio and Powell, 1983) force human agents to comply with ever more stringent financial mandates. Yet the desire on the part of the regulators to steer financial markets towards a state of *inert uniformity* by institutionalizing regulatory practices, has several challenges. As financial field and networks become entangled and fragmented, regulatory panics to impose tighter controls to enhance transparency are simultaneously institutionalized and de-institutionalized (Oliver, 1992). Evidenced by the 'twin peaks' model, in 2013 the FSA was split into two with the expectation of reducing systemic risk (Conlon and Huan, 2019). The Bank of England's Prudential Regulation Authority would regulate banks and investment firms, with the conduct of financial services regulated by the FCA.

Regulators place a high premium on technology to change and re-configure the material and social composition of financial markets to avoid the risk of contagion – e.g. the spread of a financial crisis from one country to others (Calvo and Mendoza, 2000). This *automation bias* simultaneously increases and de-creates market entropy as financial markets occupy a liminal space between stability and instability. Regulatory regimes to control financial markets become undermined as technologically enabled financial innovations flood the market (Fligstein and Habinek, 2013; Funk and Hirschman, 2014). This impacts regulatory mandates, simultaneously spawning a tsunami of regulations to meet new risk and oversight challenges.

The intention of the regulations brought in following the 2008 financial crisis was to build robust cross-border regimes and structures. Yet past regulations, such as Sarbanes-Oxley in the pre-crisis period, combined with new post-crisis regulations, resulted in greater complexity. We theorize that emerging regulations and the phasing out of old regulations exerts isomorphic pressures on regulatory regimes, leading to a state of inert uniformity, intensified as financial markets lurch from boom and bust. With each financial crisis, regulators rush to impose new laws, often with little understanding of how policy principles apply to *real world* financial market practice. The desire on the part of regulators to standardize compliance tools encourages financial agents to modify their behaviour, to meet stringent regulatory mandates. Institutionalizing codified rules and laws into financial technology allows regulators to mitigate the risks from *perceived* or *actual* self-seeking behaviour of financial agents. Yet regulators lack a clear vantage point to identify past, present and future risks. As financial regulation and technology co-exist with material and social arrangements manifested in market devices (Callon and Muniesa, 2005) 'loophole behavior' is paradoxically, prevented and encouraged. The cohesive networks of social relations between market participants coalesce to form a community of like-minded individuals, all seemingly working together to achieve a common goal of meeting regulatory mandates. Closer scrutiny of this collective activity, however, suggests technological performativity combines with effects of agencements that engender greater freedom for individuals to instantiate technology to vary the composition and configuration of compliance rules, thus creating a *perverse* technological performativity.

Financial technology is not neutral in meeting regulatory mandates. Demonstrated across our client sites, the material act of coding compliance laws and rules into software applications embodies human choices based on interpretation and judgement extending beyond technical imperatives to legal and business considerations. This adds further complexity as technology, shaped by logics of law and management, produces unforeseen and unintended outcomes.

The chronology of financial regulation shows that across the jurisdictions, regulators push for structural isomorphism through controlling the activities and outcomes of financial organizations and agents using process-based regulatory mandates (Black et al., 2007). Technology instantiates regulatory processes, but performative struggles between regulators and regulated, interpreting and applying regulatory rules and scrutinizing what is transparent (e.g. computer code) from what is opaque to regulatory agents results in a more complex, fragmented and unpredictable scenario. Regulators respond by designing and executing more rules-based mandates using technology as an agent of control. Building a *sand castle* is compromised as regulators rely on regulated firms to interpret and shape regulatory mandates, using their own context-specific judgements. This cyclical process, made more difficult as technology privileges the measurable and masks uncertainty, obscures the risks that policymakers aim to mitigate. Thus, the regulatory edifice to prevent market disruption and financial malfeasance depicted by the *sand castle*, becomes weakened and ineffective, becoming a *sand pile*.

The study has some limitations. First, methodological constraints of a limited sample size reduced the analytical scope for understanding how financial firms liaise with regulators in formulating regulatory mandates to mitigate financial market risk. Second, the research study covers only the jurisdiction of the U.K so a comparative analysis of different regulatory regimes is not possible. Third, the study draws from information systems and finance. Other disciplines, including law, and policy studies, additionally examine financial market regulation and technological change. The limitations of this study offer suggestions for further research. Using the concept

of financial market entropy, there is scope for research to compare different regulatory jurisdictions, for comparative research and case studies on dynamic and changing regulatory practices. Technology instantiates regulatory processes, but so far, few studies focus on technology drivers for regulatory decision-making, and technology as a compliance tool in regulatory oversight. Further research on regulatory processes for financial technology (FinTech) on bitcoin, cryptocurrency, blockchain and artificial intelligence in financial markets are also timely.

Conclusion

This paper makes three contributions to literature, theory and practice. First, by bringing together the literature streams of institutional theory and the sociology of finance, concepts of performativity and agencement reveal how technology instantiates financial regulation. We combine these concepts with field, network and agency to produce a multi-level analysis of how financial firms interpret, apply and monitor regulatory mandates. Providing an historical context to our discussion, we discuss the development of financial regulation over several decades observing that financial crises are commonplace. We contextualize our discussion of financial technology in emerging debates on financialization (Krippner, 2005) which invite more research on how financial innovation influences regulatory processes and outcomes (Funk and Hirschman, 2014). Second, we develop a model that links structural-agency phenomena. We show how field-level regulatory pressure on financial firms as a top-down process, is also impacted by agency-level influences that shape material and symbolic expressions of technology. Financial regulation embeds technological performativity where computer code measures and monitors financial risk in a veneer of transparency and accountability. However, rule-based mandates are open to interpretation as agents apply context-specific judgement to manage and manipulate socio-technical arrangements. Based on our empirical findings, we show that financial fields have become increasingly entangled as financial innovation, enabled by technology, has expanded relational networks across multiple jurisdictions. An interesting insight from our research arises from the networks of relationships within financial markets. Here, we observe that within the financial market ecosystem, individuals are not statically located. Significant cross-fertilisation of ideas impacts practice. Financial agents move from one firm to another, with some moving from client firms to technology vendors, and sometimes the reverse. This shows regulatory policy develops from a two-way flow of ideas where boundaries between regulator and regulated, and client and vendor become blurred. The research contributes to debates around relational networks which shape how compliance is practiced as 'a circular causal relation' involving acting and sense-making on the part of participants (Kjellberg and Helgesson, 2006). Third, our multi-level model provides a practice lens for understanding technological instantiation of regulatory practices at state, organizational and individual levels. Theorizing the role of individuals and organizations may not produce nuanced insights if the state is seen as 'an omnipresent and disembodied power' (Powell and Colyvas, 2008). We add empirical weight to this insight by illustrating entangled relationships between these levels. We show that coercive rules and regulations are not simply imposed upon institutions by a powerful state apparatus, as regulatory mandates are subject to wide interpretation by agents, who themselves may also represent *elite* or state interests. Field entanglement and market entropy are powerful analytical concepts for understanding dynamically complex financial eco-systems. Financial entropy (Zhou et al, 2013) show the markets becoming disorganized in a process of entropy as time goes on. Our conceptualization of high or low entropy uses metaphors of the sand pile and sand castle. High entropy is where the sand pile is arranged or ordered in many different ways without disturbing its structure and composition of particles. Low entropy is the sand castle ordered in a way that is vulnerable to becoming disordered. Entropy is a measure of randomness or disorder. Using these concepts, we show how financial market entropy oscillates back and forth between low to high entropy as regulators try to bring order to financial markets. More specifically, following a cycle of financial turbulence (Dagher, 2018), regulators impose new regulations with mixed results (Wah Hlaing and Kakinaka, 2018). Financial regulation alternates from coercive, rule-based mandates to less structured and deregulated regimes. Fragmentation of financial markets occurs as regulators, companies, vendors and investors increasingly operate across multiple jurisdictions. As regulators instantiate technology to define new regulatory laws and rules, financial markets move like a pendulum towards stability or instability, metaphorically illustrated by sand castles and sand piles.

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