Preliminary Report on Standards in Global Financial Markets[1]

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Abstract

This paper considers the 'market failures' that can block standardisation and recommends actions to overcome them and so ensure greater realisation of the efficiency and risk-reduction benefits of standardisation in global financial markets. It first reviews the economic benefits of standardisation and the 'market failures' (e.g. due to lack of co-ordination and vested interests) that can prevent these being achieved. It then looks at standard-setting institutions in a range of industries (physical measurement, engineering, the global supply chain, the internet) developed to overcome these market failures, comparing these with the relatively underdeveloped institutions of standards development in financial services. It goes on to examine the development of both transaction and data standards in financial markets, finding that much remains to be done, especially on data standards where the limited progress to date has relied largely on regulatory mandate. Finally it recommends two practical actions to improve standardisation in global financial markets: (i) promotion of discussion and dialogue across industry, with focus, by both researchers and practitioners, on identifying specific opportunities for using standardisation to promote business efficiency and improve market transparency; (ii) engagement of senior management in the task of building cross-industry support for both standardisation and standards institutions [199 words]

Key words: ACTUS, co-ordination failure, data standards, FIBO, financial messaging standards, FIX Protocol, FpML, ISDA, standardisation, standards institutions, Swift, XML, ISO20022, ISO TC68, FIGI

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Executive Summary

- This report is an output of a UK Government Office for Science sponsored project on standards-setting in global financial markets (focusing on technical standards for elements such as transaction messaging and reference data). For further detail see http://www.financialstandards.lboro.ac.uk/ .

- Standardisation has yielded and continues to yield very substantial economic benefits in a range of industries and economic activities, through improved efficiency and productivity, greater product and service innovation, and enhanced competition

- Market competition does not always achieve the full benefits of standardisation. The market can fail to deliver an appropriate degree of standardisation because:

    i. the challenge of co-ordination, of first agreeing on a standard (there can be fierce disagreement about the exact design of a standard) and then ensuring adoption of the new standard (the chicken-and-egg problem, as adoption of a standard typically has the greatest payoff when it is already widely adopted by others, so incentives to develop and then adopt a standard are weak without an assurance that many others will adopt the standard); and

    ii. commercial interests resisting standardisation when this reduces market power and profit margins (for example when a good or service becomes commodified through standardisation).

- These market failures are addressed by institutional arrangements for standard-setting, which have emerged in many different forms in a number of global industries (arrangements in a number of industries are reviewed here), and sometimes determined by regulatory intervention.

- Standards-setting institutions in financial markets are undeveloped compared with those that are found in other global industries, for example electronic and electrical engineering, the internet and the World Wide Web, and in supply chain, health care and manufacturing

- Within financial services, standards-setting is relatively well developed in some aspects of both retail banking and global financial markets, especially transaction messaging associated with trade execution, payments and settlement (transaction standards). Standards-setting is relatively underdeveloped for recording of financial exposures within individual firms (data and risk aggregation). This is causing particular problems because of the difficulties this poses for complying with new post-crisis regulatory requirements for OTC trade reporting, risk data aggregation and know your customer (KYC) compliance.

- Our findings in this preliminary report are further supported by an accompanying small scale "Delphi" survey of professionals involved in standardisation in financial markets (Milne & Parboteeah 2015). Although only 15 individual responded fully, there was a clear consensus that both stronger institutional arrangements and more resourcing is needed to promote standard setting in global financial markets.

- We make two recommendations for practical action:

    i. promotion of greater discussion and dialogue across industry – involving practitioners, regulators, independent experts and others – on opportunities for effective standards development and how they are best pursued, not just in transaction and messaging standards but also in contract design and data standards. The focus should be on specific and practical opportunities for using standardisation to promote business efficiency and improve market transparency.

    ii. engagement of senior management from the principal regulatory agencies and the major financial institutions (in particular the buy-

side institutions that have much to gain from greater standardisation) in the task of building cross-industry support for both standardisation and standards institutions

We further urge the industry to do more to address the relative underdevelopment of institutional arrangements for the development and maintenance of standards in global financial markets. Specific recommendations will have to emerge from the engagement of senior industry and regulatory management in improving standards-setting institutions. A first step could be the establishment of more effective informal arrangements for dialogue and communication on standards-setting, endorsed both by regulators and by industry at the most senior management level; this might eventually lead to the creation of more formal institutions for global governance of standards in financial services (on which we make a tentative suggestion in the form of a 'global financial standards forum').

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1. Introduction

This report is the first output of a Government Office for Science supported project exploring the role of standards and standardisation in global financial markets. This project is a follow-up to the Foresight Report on the Future of Computer Trading in Financial Markets (Government Office for Science 2012), in particular Recommendation A4 that standards should play a larger part in wholesale banking such that efficiency gains can be realised in computer-based trading.[5,6]

The idea for this project emerged from a workshop, hosted by the Government Office for Science in July of 2013, involving many professionals working in financial markets and involved in standards-setting.[7] The consensus at that meeting was that there has been insufficient standardisation in many aspects of financial markets and that there was therefore an opportunity for work reviewing existing standards, identifying market failures that lead to standards not being sufficiently developed or adopted, and for an exploration of what arrangements for the development and governance of standards might best support future standards development.

Despite the length of this report, it does not cover all aspects of standardisation in financial services. The scope is limited to technical standards affecting financial markets. There are many other forms of standardisation that we do not address. Four prominent examples are accounting standards, health and safety standards, professional accreditation standards and process quality standards. All of these are relevant to global financial markets (notably the capital standards set by the Basel Committee on Banking Supervision which can be viewed as a form of health and safety standard to promote the prudential safety of banks and the financial system).

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[5] Other relevant recommendations of the Foresight report include Recommendation A3 that standards should play a larger part in wholesale banking such that efficiency gains can be realised in computer based trading.; Recommendation A5 made the case for learning from other safety critical industries (e.g. aerospace engineering) to improve monitoring and management of systemic risk; and recommendation B1 that advocated the use of software for automated monitoring of extreme market events to provide assistance for regulators investing events. Our analysis builds on (Houstoun 2012), one of the 'driver reports' prepared as an input to the Foresight Report.

[6] More information can be found on the project webpages (Loughborough University 2014).

[7] While the minutes of this meeting are unpublished, we have provided a summary in our concluding Section 5 below.

Further work could well be undertaken on these other aspects of standardisation and on standardisation in other areas of financial services, such as retail and commercial banking and insurance.

This report contains three main sections. Section 2 provides an overview of the economic role of standards: what they are, why they matter, and a summary of the various arrangements for development of global standards that have emerged in different industries. It highlights a key feature of standardisation: benefits to individual organisations can fall short of total societal benefits (indeed individual organisations may actually lose customers and revenue from adopting industry standards[8]) and hence it is common to find competitors collaborating on the development of standards, directly or through standards-setting organisations, and sometimes it is necessary to have regulations that enforce adoption of standards. Similar points were raised in the discussion at the July 2013 workshop. It should not be forgotten that, even when there are substantial economic benefits from standardisation, getting cross-organisation cooperation on the development of standards, and subsequently ensuring their adoption, can be a difficult task.

Section 3 then provides a review of international standards-setting institutions, paying particular attention to the arrangements for setting standards in electrical engineering, in the global supply chain and healthcare and in the internet and the World Wide Web. We discuss the role played by formal standards-setting organisations such as ISO and review different institutional arrangements for developing and maintaining standards within particular industries. These include a leading role in standards setting by professional bodies such as the Institute for Electrical and Electronic Engineers (IEEE), global co-ordination through a network of national firm-owned membership organisations (GS1) and a multiple stakeholder involvement in standardisation of the internet and the world wide web supported by a shared commitment to transparency and interoperability (the Internet Society and the W3C consortium).

[8] The adoption of FIX and central limit order books has been an essential part of the move to computer based trading which has moved the equity market from one where commissions were 30 bps to their current levels of 0.35 bps for trade execution (Government Office for Science 2012).

Section 4 provides a preliminary mapping of the existing standards landscape in financial markets and an initial assessment of the barriers to further standardisation.[9] The levels of standards development varies considerably across different operational elements of global financial markets. In this initial review (all 'desk work' based on internet search and discussion with some individuals prominently involved in standards-setting in financial services) we distinguish between transactions standard -- where the need for co-operation between firms requires some level of agreement on business process and communication – identification standards and reference data standards used in the internal databases that record financial exposures and commitments within individual firms, which in turn provide the basic inputs for financial, management, risk and regulatory reporting.

Even within the transactions 'space' there is considerable variability in the level of standards development in global financial markets. In many transactions, most notably in money transmission and in equity trade execution, there is a relatively high degree of cross-industry standardisation; in other transactions including fixed income, foreign exchange and OTC derivatives there is more limited standardisation and sometimes there continue to be competing standards. The extent of standardisation also varies through the trade 'life cycle' with problems due to lack of standardisation sometimes emerging in the trade details required for post-trade clearing and eventual settlement (one reason for settlement failures) or in the client identification required for the allocation by intermediaries of trade purchases or proceeds to their clients.

In contrast to transactions, there has in the past been little business necessity for different firms to adopt common reference data standards in the databases they use for storing financial exposures and commitments and other business information. Industry-led efforts to establish agreed identification standards for entities or

[9] This report is still some way short of providing a comprehensive statement of existing standards in financial services. We include all the standards of which we are aware. In our ongoing work we are seeking to provide a fuller investigation of all the standards with an important role in both transactions and data referencing.

financial instruments have also failed to achieve widespread adoption. As a result the level of standardisation is far short of that found in transactions, with fragmentation or absence of standards common even within firms. As a result of growth through mergers and acquisitions, all firms of any size have multiple internal systems, each with their own data definitions and structure, within each business area, creating substantial challenges of internal data management.

This section also reviews three regulatory interventions in financial market standards: the relatively successful global LEI initiative, the requirements for OTC derivative markets reporting and the Basel Committee on Banking Supervision (BCBS) principles on risk data aggregation. These latter initiatives, in our judgement, have paid insufficient attention to standardisation and, as a result, are imposing substantial unnecessary costs on the industry. The section concludes with a summary of the barriers to greater standardisation in global financial markets, emphasising the relative lack of development of standards-setting institutions when compared to some other industries.

The final Section 5 states the main conclusion of this report – that standards and standards institutions are undeveloped in global financial markets when compared to the situation in other industries. It also returns to the discussion (recorded in unpublished minutes) of the original July 2013 meeting hosted by the UK Government Office for Science. That discussion focused on the question of why the extent of standardisation in global financial markets appears to be inefficiently low, and is largely consistent with the assessments we reach from our work in Sections 2-4. The two main market failures that prevent a purely market-based development of standards are *lack of co-ordination* and *reluctance to adopt standards in order to protect margins*. The two main responses to such market failure are co-ordination through standards-setting organisations, which are already active in financial markets transaction standards but only in their infancy in reference data standards for financial markets, and regulatory intervention to impose standards. Regulators are indeed now starting to make substantial interventions in financial markets data standards, although to an important degree these interventions are hampered by lack of attention to the detail of standards and their application in financial markets.

Section 5 also states points for further action. There appears to be a general 'prima facie' case for improved co-ordination across the industry, accompanied by much greater board-level engagement – to ensure that narrow private interests do not prevent achievement of industry-wide benefits – and also for continued close involvement of financial regulators. Financial markets remain well behind other major industries in the evolution of global standards. But achieving such co-ordination will require detailed examination of specific opportunities for standardisation and developing broad consensus on how they are best pursued. There is therefore a considerable amount that can be usefully learned from further research on specific opportunities for standards development in global financial markets and the barriers that prevent them being pursued through uncoordinated market competition.

2. What are standards, why do they matter and how are they created?

This section discusses what a standard is, the benefits of standards, and the institutions that have developed in a number of industries to help overcome the problems – both of co-ordination and of hold-up by special interests -- that can prevent the development and adoption of improved standards.

What is a standard?

Despite their economic importance, even amongst professionals working on standards there is no fully agreed definition of what a standard is. One relatively broad definition is "an agreed way of doing things" (BSI Group 2014). Another definition, offered by the International Organization for Standardisation, focuses on the documentation of standards:

"A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose."

(International Organization for Standardisation 2014)

Other definitions of standards emphasise the process through which agreement on a standard is reached. For example, BSI states that "standards are the distilled wisdom of people" and that standards are "established by consensus and approved by a recognized body". Consistent with this, standardisation can be defined as a process towards the universal adoption of a standard and a chart for the development of the standard (Cargill 2011). All these definitions, though emphasising a collective process through which a standard is created, exclude so called 'de facto' standards where there is convergence on a particular way of doing things without agreement or discussion. Often such convergence takes place on a particular proprietary technology owned by an individual firm (for example, Microsoft's Windows

operating system) due to network effects, with the attractiveness of the particular technology increasing proportionally to the size of the installed 'user base'.[10]

The view of what counts as a standard and how these should be supported also varies both from one industry to another and even within industries, depending on perceived needs. To take an example, the development of standards supporting the operation of the internet by the World Wide Web Consortium emphasises the importance of a standards community and the support of open-source (non-proprietary) standards: "W3C publishes documents that define Web technologies. These documents follow a process designed to promote consensus, fairness, public accountability, and quality. At the end of this process, W3C publishes Recommendations, which are considered Web standards." (World Wide Web Consortium 2014).

The Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA) emphasises the role of standards in improving technical performance "We are a leading consensus-building organization that nurtures, develops & advances global technologies. Our work drives the functionality, capabilities and interoperability of a wide range of products and services that transform the way people live, work and communicate."

Other types of standard are quality and also health and safety standards. These can be either voluntary or imposed by regulation. Regulation of both quality and health and safety standards are frequently applied to the supply of business-to-consumer (B2C) goods and services and in the workplace. Voluntary quality standards (or simply voluntary standards) are promoted at a national level, for example for many consumer products. Examples of these include the familiar BSI Kitemark in the UK ((BSI 2014)) or the voluntary standards supported by the Consumer Product Safety Commission in the USA (see (CPSC 2014)). There are also many national and EU mandatory quality and safety standards and a number of international voluntary ISO safety and quality standards. All these types of standard are somewhat peripheral to

[10] For discussion of the Microsoft case with reference to the literature on networks and platform competition see (Economides & Katsamakas 2006).

our own project, since our focus is on business-to-business (B2B) standards in financial markets.

Another form of standard are those for business processes, several of which have been developed by the International Organization for Standardisation (these include the ISO9000 family of "quality management standards" as well as more specific standards including ISO standards for human resources, document management, information security, regulatory compliance, energy efficiency and other business processes). Again these fall outside the scope of our project.[11]

Within financial services the emphasis in developing business standards has typically been a relatively narrow one on practical agreements to support transactions between firms. (McKenna 2011) defines a standard as "an agreement between two or more commercial counterparts on how to perform a common function". Standardisation efforts in financial services has focussed primarily on message standards (what "syntax" should be used in order that a message can be interpreted wherever it is received) and on definitions and identifiers (the agreed "vocabulary" required for a common understanding about the interpretation of the message).

While we agree that discussion must focus on the practical benefits of standardisation, we also note (and discuss further below) that this has also encouraged a widespread view, held across much of the financial services industry but unhelpful for progress on standardisation, that standards-setting is an operational detail, to be delegated to the staff responsible for operating firms' systems and not something that needs any attention at a senior management level.

Benefits of standards

While there are differing interpretations of what counts as a standard or what it should achieve, there is no doubt that standardisation has been crucial for the development, and success of the global economy. From uniform shipping container sizes (Bernhofen et al. 2013) to development of retail and supply chain barcodes

[11] Yet other standards exist, but with little relevance to our work, for example agreement on educational standards to allow qualifications to be recognised in different countries; or on political standards such as what constitutes a "free and fair" election.

(Milne 2013) and even interchangeable parts across military allies (see discussion in (Houstoun 2012)) standardisation has yielded substantial economic benefits.

The benefits standards bring to industry can be categorised into five main groups: interoperability, quality, economies of scale, measurement, innovation (this discussion draws on (Houstoun 2012)(Blind 2004) (Swann 2000) (Swann 2010):

- Interoperability is perhaps the most obvious example of the benefits that standardisation bring because it allows devices from different manufacturers to work together. Computer and electronics industries provide many familiar examples, such as HDMI and USB cable and ports, and likewise for the standards for electrical plugs and sockets, such as the 3 square-pin plug in the UK, two round-pin plugs found across continental Europe and the two flat-pin plugs in the USA and Japan. These ensure all electrical devices are capable of obtaining power from the electricity network (but also protects the interests of national plug manufacturers). Sometimes these standards are mandated by law -- for example, the EU 2010 initiative to establish the micro-USB connection as the standard for charging modern mobile phones, although this particular legislation was primarily motivated by a desire to reduce waste because old charging cables can then be re-used with new phones, rather than to promote interoperability per se. As noted by Swann (2000), however, there is one significant downside to interoperability: being locked in to an inferior product when technology permits a faster or better solution.

- Standardisation also brings with it the ability to increase the quality of goods or services (Leland, 1979). In situations where consumers are not able to distinguish easily between poor quality and good quality products, standards help to ensure that not only are buyers afforded a level of protection, but that manufacturers of higher-quality products can maintain a price premium (Akerlof, 1970). So standards help to overcome the problem of adverse selection (Blind, 2004). In extreme cases this adverse selection may result in a

form of Gresham's law (of the bad driving out the good).[12] The inability of manufacturers to maintain a price premium, when customers are confused about the quality of products, may lead to them exiting the market entirely. The introduction of standards can help avoid this outcome.

- Another potential benefit of standards comes from economies of scale, although this can bring the potentially unwanted consequence of a reduction in variety. By enabling economies of scale, standards reduce the number of variations of a product, enable materials to be mass sourced, processes to be scaled up and distribution to increase, all leading to a lower unit cost (Blind, 2004). However, in doing so, it forces a reduction in the variety of products (or services) that are available to consumers. It is a type of trade-off modelled by Dixit and Stiglitz (1977) and in this case it is between choice and cost/price.Standards that generate economies of scale are usually first formed within companies looking to reduce costs because of the immediate benefit and limited scope of the standard.

- Standards also help with defining systems for measuring and reporting information (Swann, 2000). Measurement and information standards help to confirm that something is what it says it is (product, service, description etc) and to reduce the subsequent risk to both a buyer and seller should a transaction take place. The result is a much more efficient marketplace where standards can reduce transaction costs for all parties (Blind, 2004).

Closely related is the economic contribution made by standards to reducing transaction costs, in both business-to-business (B2B) and business-to-consumer (B2C) transactions (Hudson and Jones 2000). By standardising measures for comparison, standards help to make an economic contribution by more easily

[12] The original Gresham's law applied to coins. It is the observation that if coins of different precious metal content circulate simultaneously then holders always prefer to use the coints with lower metal content (due to debasement, clipping or counterfeit) for purchase and to keep the coin with higher or full face value metal content as a store of value. Hence "bad money drives out good" i.e. the good (high metal content) money disappears from circulation and the bad money remains in circulation. Wikipedia http://en.wikipedia.org/wiki/Gresham's_law provides discussion and history back to Aristophenes play 'The Frogs'.

demonstrating the value of innovative products as well as helping to reduce risk for customers.

Further, standards also codify knowledge and best practice, and in doing so, this helps to diffuse the knowledge throughout the industry as well as encouraging a competitive process of innovation-led growth (Krechmer 2000). Ultimately, companies that use standards perform better (DIN 2000) through a process of optimisation of business processes, leading to an increase in trade (Swann et al. 1996; Blind 2000) and hence leading standardisation to contribute to economic growth (Jungmittag et al 2000).

- Finally standards contribute to innovation in numerous ways: for example, by helping to define the characteristics of processes or products to make them suitable for use and likely to succeed. Standardisation also makes an economic contribution by helping to build cohesion and critical mass in the early stages of market formation (Swann and Watts 2000) and so accelerating innovation.

It might be assumed that standards always foster innovation, but the reality is more complex than this: standards often support but can also hinder innovation. (Houstoun, 2012) provides a more detailed review of this literature. Standards support innovation by focussing research and development effort, and by reducing uncertainty for consumers purchasing products/services. However, standards can disrupt or slow down innovation, for example in what are sometimes described as "standards wars". For example, the development of the Blu-Ray standard, its challenge to the HD-DVD standard and the eventual victory of Blu-Ray is a good example where for almost three years innovation stopped until one standard was universally adopted.

This wide range of economic benefits suggests that standardisation should have a major impact on growth. An empirical literature (reviewed by (Blind 2004; Swann 2010)) examines this prediction. While the statistical problems are challenging, work conducted over the past fifteen years has attempted to quantify the macroeconomic

impact of standards development (distinguished from other factors such as technological innovation per se measured for example by patent applications, growth of labour force and investment). This research suggests that standards development has contributed as much as 1 per cent per year to GDP growth in Germany and the UK, with studies on Australia and Canada reporting somewhat lower but still substantial contributions. At a less aggregated level, standardisation has been found to lead to large increases in international trade (although in some cases, e.g. agricultural products, may serve as a form of protection and reduce trade) and is generally associated with encouraging rapid technological innovation. Other work, including (Swann et al. 1996; Bernhofen et al. 2013), finds that standardisation has a substantial positive impact on international trade.

Market failure and the need for a standards process

Business standards are very often developed through a process of collaboration among relevant, and expert, stakeholders. Most often this co-ordination takes place through formal standards-setting organisations – such as ISO, the W3C, GS1, the OMG, the IEEE and the ITU (for an overview of the different approaches to establishing standards see (Farrell & Simcoe 2012b)). Why is such an institutional process for the creation of a standard so often required and – a pertinent question for our report given the relative lack of standards development in some aspects of financial services – is there a need for further development of institutional arrangements for the development and operation of standards in financial markets?

It is possible for standards to emerge without any institutional process for the creation of a standard. This is what Swann refers to as a "market process" (Swann 2000). These are also often described as "de facto" standards. A business may develop a proprietary technology and allow this to be used freely or at low charge by others, and this in turn may become adopted as a standard by many others. A widely-cited example is the original Remington typewriter QWERTY design adopted by nearly every keyboard used for typing of the Roman alphabet. But there are many others, including the IBM desktop PC and the Microsoft Word document format (Wikipedia provides other examples (Wikipedia 2014)).

The problem with relying on de facto standards developed through such a market process is "market failure". For the purposes of this report we will take market failure to mean a situation where the outcome of the market can be improved upon by intervention, either by a broadly representative industry body such as a standards-setting organisation or through government regulation. This is a relatively demanding definition: not only must the market outcome fall short of some ideal of efficient resource allocation but the alternative of intervention must be shown to improve on the market outcome.[13]

We can highlight two main reasons why such market failure may arise and require intervention in the creation and adoption of standards in financial markets. The first is lack of co-ordination. First it is possible for market adherence to an old standard to prevent newer, more efficient standards taking over. The QWERTY keyboard is often put forward (most notably by (David 1985)) as an example of such a 'lock-in' to an old and inefficient standard. As it turns out, subsequent research ((Liebowitz & Margolis 1990; Kay 2013)) reveals the inefficiency of QWERTY to be something of a myth: it is not substantially inferior to other keyboard arrangements and was a near-ideal response to technological requirements at the time when first introduced.[14] Keyboard design is however still a good example of 'path dependence' i.e. what becomes the first established standard or technology may remain dominant thereafter.

A second reason for market failure in standards development is that standardisation can lower the market power, margins and profits of incumbents (for empirical

[13] The term "market failure" is often used more generally by economists to describe any departure from the theoretical ideal of efficient provision of goods and services in a perfectly competitive market. Examples include insufficient provision of public goods such as clean air and water; exploitation of pricing power by companies with few or no competitors; or the breakdown of market exchange because of inability to ascertain the quality of a good or service before purchase.

[14] QWERTY was developed in the 1870s for use with early Remington manual typewriters. According to (David 1985) typists would not train in the newer and superior 1936 Dvorak keyboard because hardly any offices had Dvorak typewriters and no office would buy a Dvorak typewriter because there were so few trained Dvorak typists. It turns out though that the Dvorak offered little if any real advantage in speed of typing or training (Liebowitz & Margolis 1990) and that QWERTY (which was developed on the principle of avoiding as much as possible having common letter combinations contiguous on the key board) was a near ideal response to the technical and user requirements of the time, and so would still always have won out had Dvorak been available and promoted in the 1870s (Kay 2013).

support for the hypothesis that this affects the pace of standards development in the internet see the study of (Simcoe 2012) described more fully below). If this is their perception then they will be reluctant to adopt voluntary standards. For similar reasons sponsors of proprietary standards may be reluctant to license them to competitors.

Theoretical models of 'lock-in' and standards efficiency indicate that many outcomes are possible, depending on a variety of 'network effects' i.e. the extent to which production costs or consumption benefits depends on the adoption decisions of other producers or consumers. Prominent analyses from a substantial theoretical literature include:[15]

- (Katz & Shapiro 1985) analyse conditions when, as a result of these network effects, market competition may lead to insufficient compatibility of technologies or a 'lock-in' to an inefficient early technology or standard.

- (Katz & Shapiro 1986) examine how the presence of a sponsor (an entity that has property rights to the technology and hence is willing to make investments to promote it) can both encourage compatibility and make it more likely that a long-term efficient standard is chosen. A substantial subsequent literature explores the relationship between patenting and the development of technological standards

- (Farrell & Saloner 1985) show how communication between participants (for example through a standards-setting organisation) may help achieve co-ordination on outcomes that would not arise through market competition alone. But there is a tension in such co-operation between the creation of open standards to ensure widespread adoption and capturing the value that they create through sponsorship and intellectual property rights ((Simcoe 2006; Simcoe 2007)).

[15] (Gandal 2002) provides another introductory review.

- (Katz & Shapiro 1992) show it is possible for market incentives to result in 'insufficient friction' instead of 'lock-in', with excessively rapid change in technological standards that does not take sufficient account of the costs imposed on the installed base of users of the older standard.

- (Farrell & Saloner 1992; Choi 1996) model how 'converters' that allow two otherwise incompatible technologies to work together and can reduce costs for the installed base of the older standard, but may damage incentives for the creation of a better technological standard.

- Standards are also key in the supply of network goods on so called 'one-sided' platforms – obvious examples are household utilities such as gas, electricity and water supply. Here theoretical work has highlighted how access regulation (often requiring regulatory-imposed standardisation) can support competition in upstream activities (e.g. electricity generation or gas supply) and hence reduce monopolistic rents, even while the operation of the platform itself (in these cases the distribution network) remains a monopoly. See (Vickers 1995) for a formal model. An open question is whether the platform operator should be allowed to compete in the upstream and potentially competitive market.

- Other theory considers two-sided network platforms that link buyers and sellers (including many in financial services such as payments cards, trading venues). These are two-sided in the sense that both buyers and sellers make a decision whether or not to participate in the platform, yielding the possibility of "platform competition". Theoretical work , reviewed by (Rochet & Tirole 2006; Rysman 2009), has highlighted how the possibility of charging for or subsidising access or use can be used to promote a particular standard or platform. This possibility is another influence on incentives to create new standards.

A key point to be drawn from this substantial literature is that details matter. There is no universal theory of market failure in standards development. Whether the market succeeds or not in delivering an efficient degree of standardisation depends on economic, technological and institutional factors that vary substantially across industries and products. To establish the existence of market failures it is necessary to assess the development and adoption of standards, industry by industry and often product by product.

There is a substantial case study literature of this kind examining standardisation and technological innovation in the information technology and telephony industries (for summaries of much of this work see (Shapiro & Varian 1999; Swann 2000; Evans et al. 2006)). Relatively recent and widely-cited case studies of this kind include Sun's sponsorship of the Java language and Java platform as a standard for writing device- and operating system-independent programs essential for many internet applications (Garud et al. 2002) , mobile telephony (Funk & Methe 2001; Gruber & Verboven 2001; Gandal et al. 2003; Gruber 2005), the iOS and Android operating systems (Grøtnes 2009; West & Mace 2010; Butler 2011; Kenney & Pon 2011) and wireless technologies (Lee et al. 2006; Gungor et al. 2011).

Most of these case studies have focused on the information technology and telephony industries. In these industries, standards are largely either open from the outset or (e.g. Java) have been made freely available after an initial period of licensing, supporting competition and rapid technological change. There have though been high-profile anti-trust and competition law cases against major firms in the industry, such as Microsoft and Google, and argument is made that their control over standards is sometimes detrimental to the consumer interest (these legal cases are never straightforward: for two contrasting analyses of the competition law cases brought against Google's search engine see (Argenton & Prufer 2012; Bork & Sidak 2012))

There is also a growing empirical literature on the operation of standards-setting bodies (including (Chiao et al. 2007; Farrell & Simcoe 2012a; Delcamp & Leiponen 2013) and on collaborative innovation (e.g. (Yami & Nemeh 2014)) examining the

incentives and experience of cross-industry co-operation to develop standards and technology. (Rysman & Simcoe 2008) find evidence from patent citations that voluntary standards-setting organisations support patenting and influence their subsequent adoption. (Farrell & Simcoe 2012b) review the different ways in which consensus on standards may be achieved. (Simcoe 2012) provides empirical evidence that a shift in participation in internet standards-setting to give greater voice to commercial interests (as he measures this, increased participation by 'suits' i.e. business managers relative to 'beards' i.e. technologists) has been eroding the degree of consensus in internet standards and reducing the rate of technological innovation.

There is less work on other industries. We do not claim to have been exhaustive, or even particularly systematic, but we have consulted a number of other case studies (based primarily on a number of Google Scholar citations, or our own direct acquaintance with the work). (Milne 2013) provides a history of the barcode and product identifier standards that have underpinned substantial efficiency gains in retailing, global supply chain management and other industries. The key driver in these developments was the gradual realisation that these standardisations offered substantial commercial benefits. (Trienekens & Zuurbier 2008) review the proliferation of standards in the global food industry, arguing that these impose inefficiently high costs of certification on producers and distributors. (Camfferman & Zeff 2007) provide a history of international accounting standards. (Haufler 2001) reviews the role of industry as a self-regulator in setting standards for environmental protection, employment and information privacy.

(Ko et al. 2009) survey the emergence of industry standards for the relatively new but rapidly growing industry of Business Management Process Software (software for supporting business decision-making). They attempt a typology of applications and find that standards are highly fragmented and that as a result users often fail to understand the capabilities and application of the software. (Chan & Wong 2006) explores the motivations for adoption of the ISO14001 quality standards in the hotel industry. The business applications of standards are wide. It appears they matter in almost all industries, but the relationship with innovation and growth is not always

so strong as in information technology and telecommunications; and there is always a possibility of market failure, and hence a need for either industry co-ordinated or regulatory intervention to ensure sufficient standardisation. (Barber et al. 2000) examines two UK road-building projects, finding that lack of quality standards imposes major costs and that establishing better standards is a difficult management challenge.

We draw two main conclusions from all this work on the economics of standards:

1. Standardisation can be pursued in a variety of different ways, from competition between sponsored proprietary standards through the use of convertors to co-ordination and negotiation through standards-setting bodies. Regardless of how they emerge, the governance of standards is often critical to ensuring that they are developed and supported in the broader interests of all market participants, both producers and consumers.
2. While there are common issues, it is hazardous to generalise from the experience of one industry and draw conclusions about market failure or the need for intervention in another industry. Detailed research work is needed in each particular case to provide an evidence-base for assessing the impacts of standardisation and to justify any intervention in the existing market outcome.

3. The institutions for global standards development and governance

This review of literature has highlighted the co-ordination problem that arises in the development of industry standards and the role of standards organisations in achieving co-ordination. We now briefly examine some of these standards institutions. We do not claim to be comprehensive but we do seek to provide some comparisons and draw some potential lessons for financial services and in particular for global financial markets. The main lesson is that the level of development of institutions for global standard development in financial markets is well behind what is found in many other industries.

International metrology

We begin a brief account of the international standardisation of physical weights and measures (or 'metrology' the science of physical weights and measures). National standardisation of weights and measures can be traced back to the beginning of recorded civilisation in Mesopotamia. Various Wikipedia articles recount this history, from the Sumerian measure of volume the gur-cube and the Egyptian measure of length the cubit right through to the UK Imperial measures standardised in the UK weights and measures act of 1824 and decimal metric system, based on the kilogram and metre, first developed in post-revolutionary France and fully adopted as a French national standard by Louis Philippe I in 1837.

Full international co-operation on metrology begins with the 'convention du metre' of 1875, a conference attended by the 17 countries including the recently unified nations of Germany and Italy that had by then adopted the metric system of weights and measures. This created the institutional arrangements still used today for governing metric standards. [16] The convention transferred responsibility for maintaining the standard metre and kilogram from the French Academy of Sciences to the General Conference on Weights and Measures (French: Conférence générale

[16] These were not the first international metrology arrangements. Amongst its many other responsibilities he Central Commission for Navigation on the Rhine (CCNR), created by the 1815 Congress of Vienna and still operating today, set legal standards for Rhine trade including weights and measures.

des poids et mesures - CGPM).[17] This inter-governmental organisation together with two sister bodies has been responsibility for the development of the metric system ever since, with membership increasing to 56 countries today with a further 38 associate members and an expanded remit cover all standards of physical and scientific measurement. The CPGM meets every four to six years. A significant achievement was the establishment of the SI system of international units at the 11th meeting in 1960.

One of the most substantial tasks in metrology, and an essential part of international trade and communication, has been agreeing standards for the measurement of time. Our conventional division of twenty-four hours to the day, sixty minutes to the hour and the sixty seconds to the minute is a de-facto standard whose development and acceptance is closely bound up with the history of surveying and astronomical observation and the technology of timekeeping. The practice of dividing both day and of night into twelve 'hours' can been traced back to ancient Egypt, but the notion that a hour was a fixed length of time, not affected by the timing of sunrise and sunset, emerged only with the development of mechanical timepieces in the late 14th century. The terms 'minute' and 'second' remained imprecise measures of time for considerably longer. The notion of accurate measurement of minutes and second originated with the development and many subsequent refinements of the theodolite, allowing the more precise measurement of angles first to divisions of around one minute for example by Tyco Brahe and then subsequently to divisions of one second or even less (Wallis 2005). Similarly and somewhat later the precise measurement of minutes and then seconds of time arose with the development of more accurate timepieces from the 17th century onwards (Landes 1983).

The international standardisation of time has had to deal with several related issues, including the acceptance of the second as a basic unit of time and its precise measurement, and its relationship to the length of the day allowing the for irregular and gradually slowing period of the earth's rotation. The first solution agreed by the

[17] At that time the UK, although not yet a member of the CPGM, was the technological leader in metallurgy. So it is somethat ironic that a London firm Johnson Matthey was commissioned in 1882 to forge the 'prototype physical kilo' that defined the kilo internationally (Urquart 2007).

11th meeting of the CPGM in 1960 as part of the SI system was to measure the second as one 86,400th part of the day, with the day determined as the mean tropical day by astronomical measurement. But by the 13th meeting of the CPGM in 1967 this was replaced by a standard based on the decay of caesium "The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom." (National Institute of Standards and Techology n.d.)

These differences between the actual length of the day measured by astronomical observation (now measured using a further standard known as UT1) and seconds of time measured from the atomic clock are bridged using universal co-ordinated time (or UCT) a further international time standard based on averaging a number of measures of atomic time at different locations and introducing occasional "leap seconds" to ensure that UCT and UT1 are aligned (these have always been positive so on occasion the earth day lasts not 86,400 seconds but 86,401 seconds).

Other challenges in the standardisation of time include the agreement on time zones and the international date line (another achievement of the late 19th century); and ensuring the accurate communication of UCT time (for example via radio and television, through satellite GPS systems, by telephone line or by internet). These services are essential for example to ensuring that computers, using relatively inaccurate internal quartz clocks, do not drift away from UCT. A recent development of direct relevance to modern financial markets where trading times can now be measured in nano-seconds has been the development of fibre optic time distribution that can achieve much greater accuracy than GPS and also avoid dependency on satellite signals (one such service in the UK is NPL precise time, see (National Physical Laboratory 2014)).

The global standards-setting bodies.

We next discussion some of the major standard setting bodies (other than CPGM). The global body with the widest range of involvement in standard setting is the International Organisation for Standardization, responsible for development and publication of the wide range of ISO standards. ISO has had an important role in

establishing global technical standards, including those used in most manufacturing industries (a classic example being screw threads which come under the purview of the first-numbered of the original 1947 ISO technical committees, ISO/TC1, with responsibility for "Standardization of series of internationally interchangeable fastening and traversing screw threads with a minimum variety of basic profiles, pitches and diameters including tolerances and verification").

As described on its web pages (ISO 2014) ISO is an independent, non-governmental organization whose members are the national standards bodies of 163 countries. It has a relatively small central secretariat in Geneva. The development of ISO standards is subject to four principles: 1. ISO standards respond to a need in the market (i.e. ISO does not itself initiate proposals for standards); 2. ISO standards are based on global expert opinion; 3. ISO standards are developed through a multi-stakeholder process; 4. ISO standards are based on a consensus. This process of standards development requires some time (three years is typical though if there is controversy amongst stakeholders this can take much longer).

The actual work is conducted by its technical committees. A lot can be learned about ISO simply from looking at the list of these committees on the ISO website (currently there are 259) and the standards they have published (more than 19,500 ISO standards to date). The work of these committees has gradually expanded from the first ISO committee (ISO/TC1), created in 1947 to establish international standards for screw threads, to cover a wide range of engineering and manufacturing products, services industries and other standards.

While the large majority of ISO committees publish technical standards for specific engineering and manufacturing products and services, ISO is also influential in several other areas. Standards in financial markets are the responsibility of technical committee ISO/TC68 for financial services (this work is described more fully in our next section). ISO/TC176 publishes the widely-used quality management and quality standards, with a wide range of businesses and other organisations seeking to obtain certification of compliance with ISO standards. ISO/TC27 develops environmental management standards including those covering emission of greenhouse gases.

ISO/TC223 publishes standards on societal security, including for example emergency and business continuity management.

Another long established international standards-setting body, first created in 1906, is the International Electrotechnical Commission (IEC). As described on its website (IEC 2014), it publishes consensus-based International Standards and manages conformity assessment systems for electric and electronic products, systems and services. ISO and the IEC together operate a joint technical committee to develop, maintain, promote, and facilitate standards in the fields of information technology (IT) and Information and Communications Technology.

The IEC also collaborates with the IEEE, the world's largest technical professional association which traces its roots back to the establishment in 1884 of the American Institute of Electrical Engineers, but has evolved to become a global professional organisation with membership 'composed of engineers, scientists, and allied professionals. These include computer scientists, software developers, information technology professionals, physicists, medical doctors, and many others in addition to IEEE's electrical and electronics engineering core' (IEEE 2014).

IEEE has its own standards body, the IEEE-SA, which also develops and publishes technical standards. Its work illustrates an important feature of standards: the substantial and continuing collaborative effort usually required for developing, publishing and maintaining a standard. This is what IEEE-SA describes as the 'six-stage lifecycle of a standard: initiating the project, mobilising the working group, drafting the standard, balloting the standard, gaining final approval and maintaining the standard' (IEEE-SA 2014). An effective governance structure is then necessary to ensure the process for standards development is indeed as inclusive as this description implies and, equally importantly, that standards are maintained appropriately thereafter.

Another global technical standards organisation, with an even longer history than the IEEE, is the International Telecommunications Union (ITU). In contrast to ISO or the IEC, the ITU is a public-private partnership, operating as a branch of the United

Nations with a ‘membership of 193 countries and over 700 private-sector entities and academic institutions’ and ‘at the very heart of the ICT sector, brokering agreement on technologies, services, and allocation of global resources like radio-frequency spectrum and satellite orbital positions, to create a seamless global communications system that’s robust, reliable, and constantly evolving.’ (ITU 2014). The United Nations is also involved in other various and varied aspects of international standard setting, including the United Nations Standard Products and Services Code system for expenditure and budgetary analysis and many ethical and organisational standards, for example for the civil service , prisoner welfare, packaging for dangerous goods, and (through the food and agriculture organisation) various food standards.

Three European standards-setting bodies parallel the work of the three international standards-setting bodies ISO, IEC and ITU. The European Committee on Standardization or CEN (see (CEN 2014)) co-ordinates the work of standards-setters in 33 European countries, especially in relation to promoting the development of the Single European Market in both goods and services. According to its web page, CEN has conducted work on standards in a wide range of sectors including “air and space, chemicals, construction, consumer products, defence and security, energy, the environment, food and feed, health and safety, healthcare, ICT, machinery, materials, pressure equipment, services, smart living, transport and packaging.” Financial services are notably absent from this list.

CEN works closely with CENELEC, the European Committee for Electrotechnical Standardisation, and with ETSI, the European Telecommunications Standard Institution. CENELEC describes itself as “responsible for standardization in the electrotechnical engineering field. CENELEC prepares voluntary standards, which help facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market. CENELEC creates market access at European level but also at international level, adopting international standards wherever possible, through its close collaboration with the International Electrotechnical Commission (IEC).” (CENELEC 2014). ETSI states that “ETSI, the European Telecommunications Standards Institute, produces globally-applicable

standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies." (ETSI 2014)

Standards-setting in the international supply chain and the internet

We complete this section with a brief description of how international standards are developed and governed in two other major areas of global economic exchange: the role of GS1 in developing and maintaining product identification and location standards in the international supply chain; and the development and governance of standards for the internet and the World Wide Web.

GS1 is the federation of national business standards bodies responsible for product identifiers (see http://www.gs1.org/), formed by the 2005 merger of the Universal Code Council and the EAN authority. It is co-ordinated by a Brussels-based global office which prepares voluntary global standards, including the barcode, that have been adopted in a number of industries, notably retailing, healthcare and transport and logistics. GS1 supports *four* groups of standards: (i) the large family of GDCN global identity standards including the unique GTIN identifiers for individual products and services; the SSCC shipping container code for containers, pallets and packages; and the GLN global location numbers, which can be as specific as a shelf in a warehouse or an individual division or function in a company; (ii) the wide range of linear and matrix BarCodes used for visual recording of product and delivery information; (iii) EPC global standards for storing and RFID (radio frequency) recall of electronic data off microchips; and finally the (iv) XML-based eCom standards for electronic communication between businesses.

The history of GS1 can be traced back to the early 1970s and the initiative of the US National Association of Food Chains in establishing the first and most familiar linear barcode, still used on many retail products today.[18] During the 1980s global bar-coding and identification codes were developed to support the exploding growth of world trade. It was a natural further development to establish GS1, with a member-

[18] As described in (Milne 2013),

based structure and standards philosophy apparently similar to that of ISO.[19] Like ISO, GS1 does not take the initiative in creating standards, but rather responds to requests from stakeholders. It has a relatively small central secretariat. Most work is undertaken by its member associations in 108 countries, who in turn respond to requests for standards development from business and other users, and provide a range of other services at national level such as allocation of identification numbers and technical support and training in using the various GS1 products and services (which are nowadays being extended into new areas such as traceability of origin in the food chain.)

GS1 standards have achieved global adoption in three areas of application: in retailing, the global supply chain and in health care and pharmaceuticals. The adoption of GS1 standards is an essential for competing effectively in retailing and the global supply chain, to achieve the flexibility, reliability and fast response that customers now expect. In healthcare and pharmaceuticals GS1 standards have offered a means for communication of key information needed for correct dosage and inventory management.

GS1 standards also support standards used in a number of other industries, but with varied levels of development and adoption and often on a national and not global basis (one example described to us is the involvement of GS1 Germany in the development of standards for automotive parts for the German industry). This reflects the user-driven nature of its standards: GS1 only works on global standards where there is an industry appetite for their development and adoption.

A distinctive approach to standards-setting has developed for the internet and the world wide web, with an explicitly stated philosophy of openness and inclusivity. In the case of the internet (the arrangements that link computers around the world) standards-setting is championed by the Internet Society which describes itself as 'a

[19] We have been unable to locate a formal statement of the principles followed by GS1 in creation of their standards. GS1 staff in their UK office have explained their standards creation process. We understand that like ISO they respond to requests for standard development from standards users, primarily corporate members of the various national GS1 member organisations, and then co-operate with GS1 member organisations worldwide to develop consensus amongst users.

global cause-driven organization governed by a diverse Board of Trustees that is dedicated to ensuring that the Internet stays open, transparent and defined by you' (Internet Society 2014b).

The Internet Society is closely involved with three of the key bodies who work on internet standards: the Internet Engineering Task Force (IETF), the Internet Research Task Force (IRTF) and the Internet Architecture Board (IAB). The IAB 'is responsible for the overall architecture of the internet', the IRTF 'promotes research of importance to the evolution of the future Internet by creating focused, long-term and small Research Groups working on topics related to Internet protocols, applications, architecture and technology' while the IETF is 'the protocol engineering and development arm of the Internet' (IETF 2014a). 'These organizations are all open, transparent, and rely on a bottom-up consensus-building process to develop standards. They help make sure open standards have freely accessible specifications, are unencumbered, have open development and are continuously evolving'(Internet Society 2014a).

The IETF in particular develops many internet engineering software standards, following its *Internet Standards Process*, which it describes as follows:

> 'In outline, the process of creating an Internet Standard is straightforward: a specification undergoes a period of development .. and revision ..., is adopted as a Standard by the appropriate body... and is published. In practice, the process is more complicated, due to (1) the difficulty of creating specifications of high technical quality; (2) the need to consider the interests of all of the affected parties; (3) the importance of establishing widespread community consensus; and (4) the difficulty of evaluating the utility of a particular specification for the Internet community. The goals of the Internet Standards Process are:
>
> - technical excellence;
> - prior implementation and testing;
> - clear, concise, and easily understood documentation;
> - openness and fairness; and
> - timeliness.
>
> The goal of technical competence, the requirement for prior implementation and testing, and the need to allow all interested parties to comment all require significant time and effort. On the other hand, today's rapid development of networking technology demands timely

> development of standards. The Internet Standards Process is intended to balance these conflicting goals.' (IETF 2014c)

One aspect of internet standards is the allocation of unique parameters on the internet (IP addresses, DNS domains). Historically these arrangements are a little more complicated than for other internet standards, involving both the US government and the global internet community. The Internet Corporation for Assigned Names and Numbers (ICANN), working under a contract to the United States Department of Commerce National Telecommunications & Information Administration (NTIA), is responsible for co-ordination of the unique domain numbering and IP address systems that allow computers to find each other on the internet (ICANN 2012). The detailed work is carried out by a division known as the Internet Assigned Numbers Authority IANA working closely with the IETF (see (IANA 2014)). The NTIA has now announced that it plans to relinquish the stewardship of internet domain and protocol numbering and discussion is now ongoing about new globally-based governance arrangements for IANA (on this see (IETF 2014b)).

A major part of the internet is the World Wide Web i.e. the massive and continually growing set of HTML pages. Standards for the World Wide Web are established by the World Wide Web Consortium (W3C), based at the Massachusetts Institute of Technology. W3C supports standards for a wide range of web page-based applications, going well beyond the display capabilities of HTML.

Like the Internet Society the W3C is committed to the creation of open and inclusive standards. This is how it describes its work on standards:

> 'W3C standards define an Open Web Platform for application development that has the unprecedented potential to enable developers to build rich interactive experiences, powered by vast data stores, that are available on any device. Although the boundaries of the platform continue to evolve, industry leaders speak nearly in unison about how HTML5 will be the cornerstone for this platform. But the full strength of the platform relies on many more technologies that W3C and its partners are creating, including CSS, SVG, WOFF, the Semantic Web stack, XML, and a variety of APIs. W3C develops these technical specifications and guidelines through a process designed to maximize consensus about the content of a technical report, to ensure high

> technical and editorial quality, and to earn endorsement by W3C and the broader community' (W3C 2014).

Amongst the W3C standards, two are of particular relevance to financial services: (i) XML or Eextensible Mark-up Language, and (ii) the RDF/ OWL language which supports the development of the so-called "Semantic Web". We briefly describe both of these.

Extensible Mark-up Language (XML). XML is a flexible 'mark-up' schema for the transport and storage of data. It is not itself a specific computer language, but rather a framework that can be used to create languages for describing the transport and storage of particular types of data. One example is that XML has been used to develop XBRL (described in Section 4 below), the mark-up language for financial reporting. It is complementary to the HTML 'mark-up' language which has become the universal standard for describing the presentation of data on web pages. A combination of XML implementations and HTML can support interaction between web pages and databases.

The 'Semantic Web': *RDF and OWL.* RDF stands for Resource Description Framework and is a standard for describing and categorizing web resources. HTML was designed to make web pages that are easily read by humans. RDF is designed to allow computers to read this same information.

OWL stands for Web Ontology Language and is built on top of RDF to enable more sophisticated automated processing of information on the web by computers. It is written in XML, and hence not designed to be human-readable.

Figure 1 represents the relationship between these different constructs and how they are represented in the semantic web. The Semantic Web is comprised of 7 layers starting with URIs, which are essentially single facts (e.g. Charles is Harry's father). The next level is XML which is used to describe the data/facts found in the level below. It is important to note that by itself, XML does not do anything: it is simply information wrapped in tags.

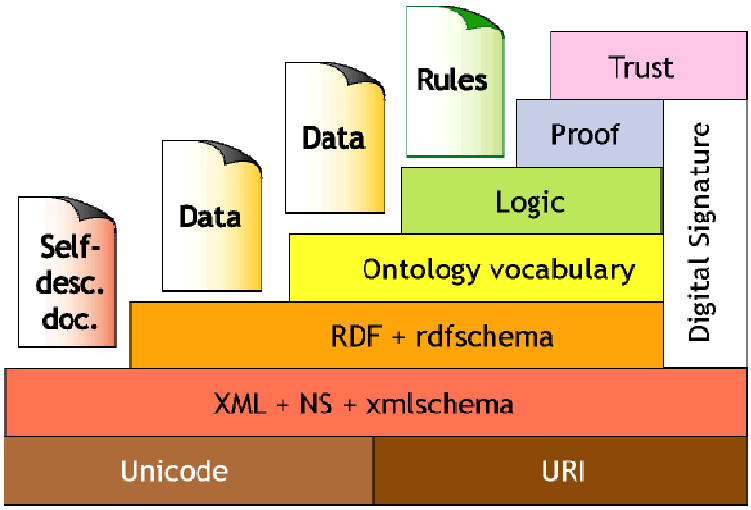


Figure 1 The Semantic Web Stack (source: (Berners-Lee 2000)). A version of this figure was first created by Tim Berners-Lee in the 1990s and evolved to incorporate subsequent developments in the Semantic Web.

RDF was designed to provide a common way to describe information so it can be read and understood by computers. RDF was originally designed as a metadata data model but is now used more generally for the conceptual description of information in web resources. RDF statements have a "triplet" structure in the form: <object or resource>, <property>, <class>. The set of possible properties is quite limited: the principal properties are "type", i.e. belongs to, "subClassOf", "subPropertyOf", and also "range" and "domain", which limit the classes that can use a particular property. There are also human-readable "labels" and "comments" in RDF.

RDF is a part of the W3C's Semantic Web Vision where information is not vague or inexact (it carries a precise, unambiguous meaning). This allows information processing of higher orders to be carried out by computers and computers can integrate, aggregate and synthesise information from the web.

Ontologies and their languages (of which OWL is one) form the next layer on top of RDF. OWL is a knowledge representation language for creating ontologies (or knowledge bases) and is characterized by a formal specification in RDF. OWL can allow computers to process information intelligently. An ontology, in this context of the automated computer processing supported by the Semantic Web, has been (rather obscurely) defined as "a formal specification of a shared conceptualization"

(Gruber 1993). Gruber's intention in describing an ontology in this way was to explore precisely how the language used for describing objects and the relationships amongst them could be made completely portable i.e. independent of operating system or machine.

A successful ontology should be both adequately complete and precise to be implemented in any desired computational environment. An ontology requires exact descriptions about things and their relationships with other things and permits computers to go beyond merely displaying data to humans. This requirement for completeness of relationships is a demanding one and limits the scope of an ontology, in this strict sense, to a specific area of business activity.[20]

Note that the same term 'ontology' is also used in a broader sense when applied to an organised description of terms and the relationship amongst them, that is then used to support information retrieval and processing, both manual and automated, across a broad area of activity. Two examples are the FIBO initiative in financial services described in Section 5 below and the SNOMED medical ontology. The implications of such broad ontologies for financial services are discussed further by (Parboteeah & Milne 2014) who note that creating such an ontology is a lengthy project. The development of SNOMED took some forty years.

RDF and OWL are not sufficient on their own to support automated computer information processing and reasoning: they must be implemented in a particular context. Many entities have been involved in efforts of these kinds. One example is the "Object Management Group"(OMG), another prominent information technology standards-setting organisation (see (OMG 2000)). OMG describes itself as a "*not-for-profit technology standards consortium. Founded in 1989, OMG standards are driven by vendors, end-users, academic institutions and government agencies. OMG Task Forces develop enterprise integration standards for a wide range of technologies and an even wider range of industries. OMG's modeling standards, including the Unified*

[20] For related argument see (Milne & Chisholm 2013) who argue that a 'common language' for automated computer processing i.e. an ontology is only feasible for particular 'communities of interest' engaged together in closely related business activities.

Modeling Language (UML) and Model Driven Architecture (MDA), enable powerful visual design, execution and maintenance of software and other processes."

OMG, which works closely with both ISO and W3C, has been closely involved in efforts to develop and implement ontologies for Semantic Web application (see (Kendall et al. 2009)). As described below in Section 4, it is also now involved in developing an ontology for the financial industry (FIBO). In 2014, the OMG also adopted a new Financial Instrument Global Identifier (FIGI) standard for the unique and persistent identification of financial instruments across all asset classes.

Finally, to support further co-ordination on many aspects of the internet including standards development, many of the various bodies involved in internet standards all participate in the Internet Governance Forum, an annual event supported by the United Nations (for details and documentation of these forums (Internet Governance Forum 2014)).

4. The standards landscape in global financial markets

The objective of this section is to provide a preliminary review of existing standards and level of standards development in global financial markets. Our principal conclusions are that these standards remain fragmented, creating unnecessary costs and risks across the industry, and that one major reason for this continued fragmentation is that the institutions for global co-ordination of standards are less developed in financial markets than their peers in other major global industries.

One consequence of the fragmentation of standards in global financial markets is the rather disconnected nature of the material presented in this section. We have struggled to present this material in a unified and coherent way, but we were unable to find any obvious theme or structure which could link together all the different aspects of standardisation in financial markets. Instead we have ended up with a series of sub-sections only loosely linked to each other. There is though one common theme: as already noted, relative to some of the other industries reviewed in the previous Section 3, the institutions for developing and maintaining common standards in global financial markets are relatively underdeveloped.

This section is divided into six subsections: (i) a review of the very limited research literature on standards in financial services; (ii) a summary of the different messaging and communication standards used in global financial markets (the business functions where most progress on standardisation has been made); (iii) a brief review of the wide range of numbering systems used by market participants, for the identification both of financial instruments and of legal entities; (iv) a description of three recent efforts by regulators to promote greater standardisation, of which one (the Global LEI System) has been slow to organise but effective in achieving its relatively simple objective of establishing a globally-accepted identifier for legal entities participating in financial markets (but fast in comparison to the industry's normal timescale for the development and adoption of standards); and two others (the creation of universal transaction identifiers and the Basel principles for risk and data aggregation) which have been – in our judgement – counterproductive creating obstacles to rather than supporting greater

standardisation across the industry; (v) a short summary of two more promising recent initiatives – the work of the Enterprise Data Management Council and in particular its FIBO or 'Financial Industry Business Ontology', as well as their support for the development of the OMG's FIGI standard: and ACTUS or 'Types Unified Standards' which may in future help support automated processing in financial markets; and finally (vi) an overall assessment of the progress of standardisation in global financial markets, which we attribute in large part to the absence of effective governance arrangements for standards in global financial market.

Existing research on standard setting in financial services

There has been little prior research on standards and standards- setting in financial markets. (Leibbrandt 2004) examines the conditions in which technological lock-in can prevent standards and technology development in payments systems and finds, in contrast to standard literature, that sponsorship of technology can sometimes increase rather than reduce the possibility of lock-in to an inferior standard.

The contributions of (Milne 2006; Milne 2007) described above suggest that the reliance on shared infrastructure can weaken incentives for standards and technological development in both retail payments and securities settlement. (Mainelli & von Gunten 2013) have recently argued, in a wide ranging historical and institutional review, that voluntary standards can be a more effective means of improving the safety and stability of the financial system than regulation (a point with which we agree, though we believe they understate the institutional challenges to effective development and adoption of standards).

Building on this work (Mainelli et al. 2014a) and (Mainelli et al. 2014b) has investigated opportunities for standards development in the insurance and asset management industries respectively, soliciting practitioner and industry opinion using workshops, questionnaires and informal interviews. It reports substantial demand for standardisation of various kinds, which is perceived as offering large potential cost-reduction and efficiency benefits and also supporting customer transparency and improving governance and risk management.

(Mainelli et al. 2014a) identifies specific opportunities for standards development in insurance (developing standards and certification of transactional data exchange; certification of model-building and model data exchange with industry actors; standardized policy wording and anti-fraud standards) and recommends that the British Standards Institute explore the possibility of developing voluntary industry standards in these areas. It also recommends exploration of opportunities for further standardisation that can improve business process efficiency and risk and regulatory reporting.

(Mainelli et al. 2014b) similarly recommends exploring opportunities for standardisation in investment and asset management, in particular on: governance and responsible investment; the disclosure of management fees and charges; and data standards, particularly around internal processes and to meet regulatory requirements.

This work illustrates the range of benefits obtainable from voluntary standardisation in these two major segments of the UK domestic financial services. Similar benefits are clearly available from standardisation, both in other domestic financial services and in global financial markets.

Our own analysis of the previous sections though suggests that 'market failures' may pose substantial barriers to the development and adoption of such voluntary standards. Standards-setting organisations may help overcome the challenge of co-ordinating the work of developing standards (although success is by no means guaranteed, especially if different industry participants have different views about what should be standardised), but even when standards are developed this does not guarantee that they will be adopted. This is particularly true of the recommendations Z/Yen Group makes about disclosure and transparency and on improvement of data management and internal data processes. Without compulsion, e.g. through regulatory mandate, these proposals for standardisation of internal business processes may not be pursued or adopted.

A similar cautious perspective emerges from two previous studies by one of our co-authors. In a review of the history of the barcode (Milne 2013) notes that the initial

technological development depended on the contributions and commitment of a small number of talented engineers, motivated not by prospects of bonuses but by their desire to find and implement technological improvements in retail sales and distribution. This is very different from the dominant remuneration-focussed business culture in global financial markets. Also it is unclear if any standardisation in financial markets can offer the same high level of return on investment (RoI) to adopting firms as was achieved from investment in the barcode and point-of-sale scanning, and hence incentives for adoption may be correspondingly weak.

(Milne & Chisholm 2013) argue that the benefits of standardisation of descriptions of data and financial contracts ('common language') are specific to particular 'communities of interest' within financial services, implying that standardisation must be undertaken on a gradual and step-by-step basis, one area of business activity at a time. The FIBO and ACTUS initiatives described below suggest that this assessment may be rather too pessimistic, and that real business and economic benefits may be achievable from an industry-wide approach to standardisation in global financial markets.

Messaging and transaction standards in financial markets

Over the past few decades most standardisation activity in financial markets has been in the domain of payments and transaction messaging. Houstoun (2012) identifies four main groups of standards used for financial market transaction and payment messaging:

- the FIX Protocol (FIX), the standard for securities transaction messaging maintained by FIX Trading Community
- ISO messaging standards (as, for example, used by SWIFT)
- FpML the standard for OTC derivative business processing and messaging
- XBRL the XML based business reporting language, primarily used for financial reports.

We briefly describe these four standards (see (Houstoun 2012) for further detail).

FIX was launched in 1992-1993 as a collaborative venture between the US broker-dealer Salomon Brothers and Fidelity Investments (for more detailed review and assessment see (OXERA 2009; Milne & Chisholm 2013)). FIX was an immediate success and in the years following the January 1997 launch of FIX Protocol version 4.0 it became the almost-universal standard for pre-trade and trade-execution messaging in cash equity markets.[19] There are 18 application messages (for various types of instruction such as execution of an order) in FIX 4.0 and 140 defined fields. These have been subsequently expanded, and by the December 2006 release of FIX version 5.0 there were 101 types of application message and 1,139 defined message fields.[21] This expansion extended the application of FIX to fixed income, money market, foreign exchange, cross-border and derivatives transactions and for post-trade processing, and offered functionality for a much wider range of entities (not just equity broker-dealers and their customers) to use FIX. FIX Trading Community publishes its messages and guidance on their use in a set of seven volumes that cover both the messages and their usage. Further information on the usage of the messages can be found in other documentation available on the FIX Trading Community web site. FIX Trading Community also publishes a data repository that describes the message content and how it is assembled into messages.

SWIFT – the Society for Worldwide Interbank Financial Telecommunication – was created as a bank-owned co-operative in 1973 to solve problems arising from the growing use of teleprinter exchange (telex) on international telephone lines for international payments messages (see (Scott & Zachariadis 2010) for a history of SWIFT). Even then lack of standardisation was a key issue: telex payment instructions were sent in free text, sometimes requiring the exchange of as many as ten messages to confirm payments details and raising obvious security concerns.

Over the subsequent forty years SWIFT became the accepted secure messaging system for inter-bank cross border payments, introducing dedicated terminals in 1981, and has co-operated with ISO and industry practitioners in the development

[21] Source: FIX 5.0 documentation. FIX 5.0 also introduced a 'transport' independent version of FIX, separating the administrative messages as a separate transport standard (FIXT) and so allowing the application messages to be sent using any chosen communication protocol.

of a wide range of financial messaging standards in banking, payments and financial markets (notably the ISO15022 and ISO 20022 standards for payments, securities settlement and reconciliation) and in domestic payment systems. In 2004 ISO introduced ISO2022, which as described in (SWIFT 2010) is a 'recipe for making financial messaging standards', setting out in a structured way a common approach to establishing and then implementing standards for financial messaging. ISO 20022 can thus be described as a methodology for creating standard messages. The ISO20022 methodology can be used to produce multiple standard message formats to address similar processes. In reality there can be multiple syntaxes of ISO20022.

ISO 20022 distinguishes the business concepts from the representation in computer-readable form through distinguishing three separate 'layers':

- identification of key business processes and concepts
- logical (communication standard-independent) message construction
- implementation in a particular communication standard ('syntax').

The functionality of ISO 20022 is delivered by its repository – a web-based dictionary that defines all the components of both business processes and financial messages used in the various financial transactions covered by the standard *and* provides links to tables of all the information that may be needed to refer to these components in the construction and execution of a financial message. According to (SWIFT 2010) this repository 'holds several hundred business components, around 700 message components and more than 250 message definitions'.

FpML – or "Financial Products Mark-up Language" - describes itself as an e-business language for describing financial derivatives and associated business interactions based on industry standards. It grew out of a 1997 initiative by JP Morgan, working with PriceWaterhouseCoopers (PWC), to support electronic trading and confirmation in the rapidly-expanding OTC derivatives market.[22] Since 2001 the governance and

[22] (ISDA/FpML 2004)

development of FpML has been integrated into the International Swaps and Derivatives Association (ISDA) organisational structure.

A technical overview of FpML is available at (ISDA/FpML 2012c), with links to a number of supporting documents. At the heart of FpML are a large number of "schema files" (these can be viewed through its public-domain online documentation), which describe the XML messaging for the various OTC products it covers and the different business processes – such as confirmation, collateral management, trade reporting. Overviews of the coverage of FpML are provided by its 'product framework model' and 'messaging framework' ((ISDA/FpML 2012b; ISDA/FpML 2012a). The first of these provides a product mapping for the various standardised financial derivatives included in FpML (based on interest rates, equities, foreign exchange, bonds, credit and commodities). The second provides the range of messages allowed in FpML (principally 'confirmation view' messages, which require very complete and accurate detail, and 'reporting view' messages, used for management functions such as collateral management which can be more loosely structured).

A key difference between FpML, on the one hand, and FIX and the various ISO messaging standards on the other, is that FpML provides a close integration of business processes and messaging. A firm might choose to use FpML purely internally in order to manage communication within its own systems. Both FIX and ISO messaging are characterised by a layering, distinguishing business and message standards, whereas in FpML these two are intertwined. Both FIX and ISO standards attempt to explain the business process in supplementary usage documentation.

Different again is XBRL. This is not a financial messaging or business process language for financial transactions. It is rather a set of technical standards, based on the eXtensible Mark-up Language (XML), that "allows the definition, preparation and exchange of reporting information across organisational boundaries used in all industries. It does so in a manner that can be validated at every point in the process" (XBRL.org 2014a). XML provides message syntax – rules about how messages are constructed – while XBRL provides business reporting semantics – agreement on

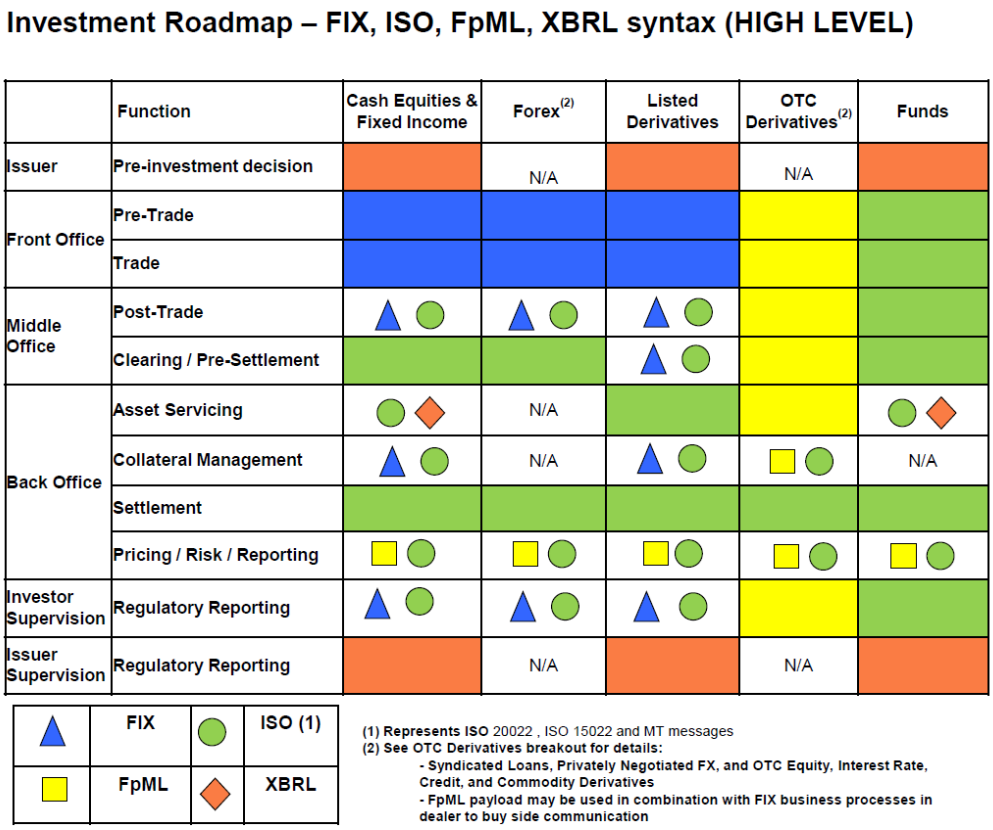
standardised meanings for business information. While developed initially for financial reporting in the late 1990s (some of the history is recounted in (Kernan 2009)), it is now finding application in a range of industries and in a range of contexts for the exchange of business and financial data, including regulatory reporting by banks, company registration, tax administration and even corporate social responsibility reporting.[23]

Significant boosts to the adoption of XBRL were the decisions, first in 2006 by the FDIC (the US Federal Deposit Insurance Corporation) and then in 2009 by the SEC, to phase in mandatory XBRL regulatory filings for banks and for issuers of publicly-traded securities. Since 2011 all public companies in the USA have been required to submit their filings under XBRL. However there were concerns about initial teething problems with data quality (see (Debreceny et al. 2010; Du et al. 2013)) and more importantly doubts whether this regulatory mandate was achieving the wider goal of improving corporate transparency. As (Harris & Morsfield 2012) note "Ironically, a lot of effort in XBRL has shifted towards providing structured data in other areas like corporate actions and governmental databases where there is less competition in the provision of such data than there is in the world of corporate financial information."

An overview of these four standards and their role in financial messaging and transaction communications has been provided in the Investment Roadmap (Standards Coordination Group 2010).[24] The key figure from this road map is reproduced as Figure 2 below. This is organised into a grid with functional category on the vertical axis and asset classes on the horizontal axis. The cells are colour coded (blue – FIX, green – ISO, yellow – FpML, orange – XBRL) with shapes used where standards overlap.

[23] A list of XBRL projects can be found at (XBRL.org 2014b), at time of writing about 160 separate projects in more than thirty countries were listed.
[24] For further discussion see the Investment Roadmap FAQ, downloadable via (ISO20022 n.d.).

Figure 2: The Investment Roadmap



This figure both confirms the usage of the four main standards and also illustrates the extent to which multiple standards are being used in some contexts. The FIX Protocol is the most widely-used standard for pre-trade and trade execution messages, FpML is the most widely-used standard for OTC derivative transactions, and ISO (15022/20022) is most common in payments and settlement.

This figure also highlights the range of activities in which these standards are used: in addition to payments and trade execution and settlement, these messaging standards are used in price and risk reporting, collateral management and regulatory reporting. A particularly difficult challenge is automation of asset servicing (dealing with a range of 'corporate events' such as dividend and coupon payments and mergers and acquisitions, and also the allocation of income and the proceeds of sale amongst participants in investment funds). Here, as already mentioned, the XBRL business reporting language has been applied. According to (XBRL.org 2014b) it

provides descriptions of forty different corporate actions, using an underlying set of 200 definitions of business concepts.

The ambition of the Standards Co-ordination Group in creating the Investment Roadmap is to examine the scope for integration of these standards into a broader common framework, allowing further standards development, potentially under the more general ISO 20022 process, but at the same time protecting the investments of market participants. But as our description of these standards makes clear, this is an ambitious agenda that will take both time and strong commitment from senior management of businesses if it is to be achieved.

Industry efforts at creating voluntary standards for the identification of securities and legal entities

One early effort at standardisation has been the development of the International Securities Identification Number standard (ISIN). This is an ISO standard (ISO 6166) for which the Association of National Numbering Agencies (ANNA) is the ISO-recognised registration authority) (ANNA 2014). ANNA is also responsible for ISO 10962, the six-digit Classification of Financial Instruments (CFI) code,

The concept behind the ISIN standard is a simple one, that of combining in a single global standard a variety of industry and market conventions for identifying different securities. The ISIN code consists of a two-character country code, a nine-digit national domestic identifier for the security and a check digit. An ISIN therefore incorporates (in the nine-character national identifier) the CUSIP numbering employed in the US and Canada, SEDOL numbers employed in the UK and other national conventions for identifying securities.

In practice security identification has remained fragmented, even in the major financial centres such as London and New York. A wide variety of other identifiers (exchange ticker codes, Bloomberg IDs, Reuters Instrument Code (RIC) and others) are used alongside the ISIN numbering for providing pricing and other information to market participants. ISIN itself is often regarded as a relatively technical “clearing and settlement” solution.

Competition between instrument identification systems continues. In a promising initiative Bloomberg has recently supported the development of and adopted the OMG FIGI standard, resulting in an 'open symbology' approach, developing an identification system for financial instruments that can be used freely by any market participant, whether a Bloomberg customer or not (see (Bloomberg n.d.) though this identification system will of course be fully supported by Bloomberg terminals. This system has been designed to cover all financial instruments – derivatives and funds as well as securities – and so that the codes (unlike ISINs or exchange ticker codes) remain invariant to corporate actions such as, for example, temporary de-listings or secondary issuance. FIGIs also uniquely and persistently identify a financial instrument by trading venue, resulting in greater granularity of identification within a single standard.

As an open standard the Bloomberg approach has been adopted by the Object Management Group, and Bloomberg changed the naming of the instrument identifiers it uses in October 2014 from BBGID (Bloomberg Global Identifier) to FIGI (Financial Instrument Global Identifier), a change in name emphasising the platform-independence and non-proprietary, open and free status of the identifier (see (Bloomberg 2014) which writes "Stripping the BBGID of the Bloomberg name allows for a neutral, generic standard that avoids the branding issue. Bloomberg will continuously build, update, and administer FIGI identifiers to ensure their accuracy and effectiveness – but we also welcome the opportunity to help companies, exchanges and 3rd parties integrate FIGI into their databases. Adopting an open system of shared symbology establishes the foundation for a tremendous leap forward in the efficient trade and settlement of securities. The adoption of the FIGI will enable firms and technology service providers to shift resources from laborious, inefficient processes to new investments in tools and products that will better serve organizations of all kinds.").

FIGI was developed with support from the Enterprise Data Management Council, so should align well with their FIBO ontology (described later in this section). ANNA, as Registration Authority for the alternative ISO-supported system (ISIN), however appears far from ready to concede the position of standard global instrument

identifier to FIGI.[25] It remains to be seen how and when FIGI – or some other system of identifiers – will emerge as widely used and adopted by investment firms internationally.

ANNA also maintains the CFI codes, a relatively high-level classification system in which the first character distinguishes the type of instrument (E = Equity, D= Debt, R= Rights, O=Options, F= Futures and M= Miscellaneous), with the second character classify types of instrument e.g. debt, equity and the remaining four codes capture attributes such (for example fixed interest, floating interest). While the CFI codes have been around for some time (originally adopted in 1997 and currently undergoing a further round of revision), they also face an adoption challenge, to our knowledge there has been relatively little uptake of the CFI by market participants.

The creation of a standard system of identifiers does not of itself ensure adoption: there has also to be a business case for market participants to change their own systems and incorporate standard identification systems. As we emphasise at many points in this report, co-ordination on a single standard in financial markets is often hampered by the lack of engagement from senior management across the industry. A regulatory mandate may often be the strongest reason for so doing, but requires detailed consultation and interchange of views to ensure that a regulatory-imposed solution is consonant with market practice and does not impede rather than promote the reduction of cost and risk.

A similar fragmentation has applied to the identification of legal entities , where again a number of different systems are used. Each jurisdiction has its own system of identification for registered corporations. ISO-standard Business Identifier Codes (BICs) are used for international bank payments (but these are not legal entity identifiers and apply only to banks and other organisations in their role as clients of banks). Dun and Bradstreet numbers are often required for example in US government procurement. Regulatory and self-regulatory bodies often create their own legal entity numbering systems: for example the US National Futures

[25] See (Kentouris 2014) for an assessment of the competition between ISIN and FIGI numbering.

Association (a self-regulatory body) has a 7-digiti system for identifying participants in US derivative markets. Credit referencing agencies and data vendors, including S&P, Avox, Omgeo, FactSet, Bloomberg, Thomson Reuters, Telekurs and Markit, offer their own systems for identifying entities or counterparties in data aggregation. However, as we describe in the next sub-section, regulators have made an effective step towards creating and endorsing a universal global identifier through the creation of the global Legal Entity Identifier (LEI).

Current regulatory initiatives affecting data and identification standards.

We now describe three current regulatory initiatives affecting financial market standards: the global LEI system for unique and universal identification of legal entities; trade identifiers required for reporting of OTC derivative trades to central repositories; and the BCBS239 principles for risk data aggregation and risk reporting by SIFIs (systemically-important financial institutions).

While not reviewed in this paper, we note that other regulatory initiatives have led to important improvements in data recording and management. In the USA the process of stress-testing has, despite some objections by firms, forced the industry to make substantial investments to improve systems for recording of exposures and aggregating risk exposures.[26] For example, this process has forced firms to develop firm-wide 'data dictionaries' to ensure that their reporting and stress-tests are conducted on a consistent basis across and between firms. A separate initiative of the Austrian central bank has promoted a more granular recording of risk exposures, hence supporting more effective risk aggregation amongst Austrian commercial banks.[27] Another example of successfully regulatory-led standardisation has been the creation of SEPA, the Single European Payments Area initiative, but this has depended critically on close engagement with industry through the European Payments Council (see (European Payments Council n.d.)). We do not describe these initiatives in detail since they are national or regional and not global.

[26] Granular data is reported by the largest Bank Holding Companies in a new quarterly regulatory report, the FR-Y-14Q; for versions of the reporting firms and instructions since 2012 see http://www.federalreserve.gov/apps/reportforms/reporthistory.aspx?sOoYJ+5BzDZGWnsSjRJKDwRxOb5Kb1hL

[27] See (Hille 2013)

The Global Legal Entity Identifier

In June 2012 the Financial Stability Board announced that it was to establish a global system for the unique and unambiguous identification of counterparties and clients in wholesale financial markets.[28] This followed the agreement amongst the G-20 countries at the Pittsburgh summit to introduce mandatory reporting of OTC derivative trades to trade repositories and to require clearing of standardized OTC derivatives in central counterparties. As the US authorities implemented these requirements, as specified in the 2010 Dodd-Frank act, they proposed that a regulatory-mandated standard legal entity identifier (LEI) should be used for trade reporting. The Financial Stability Board then took the lead on developing this identification scheme when it became apparent that such a scheme was only fully workable if implemented at a global level.

To date the primary application of the LEI has been in the implementation of the requirements of the US Dodd-Frank Act and the EU European Market Infrastructure Regulation for the recording of OTC derivative contracts in trade repositories. The US Commodities Futures Trading Commission (CFTC) – the US regulator responsible for implementation of this part of the Dodd-Frank Act - commissioned the US Depository Trust & Clearing Corporation (DTCC) to provide so-called interim compliant identifiers (CICIs). These are one example of so called 'pre-LEI' identifiers (others have been issued in Germany, France and the UK and other jurisdictions) that complied at the time with the requirements announced by then for the issue of LEIs.[29] The full Global LEI System was eventually launched on 26th June 2014 with the first meeting of the Global LEI Foundation (a charitable foundation established in Switzerland that controls the Global LEI System). Oversight of the Global LEI System is by a group of international regulators (the Regulatory Oversight Committee).[30] These arrangements will ensure that the LEIs issued by the various Local Operating

[28] This description draws on and updates (Chan & Milne 2013)

[29] A GS1 website (GS1 2014) provides access to all pre-LEI reference data. The global LEI foundation will launch a central operating unit for the LEI and this is expected, eventually, to be the standard source for LEI data.

[30] Details about the establishment and activities of the GLEIF can be found at (LEI ROC n.d.). For fuller discussion of the development and application of the LEI system see (Ali 2014; Milne & Parboteeah 2014; Alexander 2014; Janssens 2014)

Units in different jurisdictions comply with globally-set standards for data quality and verification, and can be accepted as identifiers across the world.

The potential benefits from the LEI system are large, both in terms of improving efficiency (reducing costs) at financial institutions and supporting better quality data and information for risk management and regulatory oversight. There are not indications from European and Japanese regulators that the LEI will be mandatory in many other aspects of regulatory reporting. In addition there is at present no standard identification system for use across the industry in customer on-boarding, in maintaining know-your-customer (KYC) and anti-money laundering (AML) systems, or for supporting straight-through (automated) transaction processing. (Chan & Milne 2013) estimate that removing duplication and reducing manual interventions in these systems can result in potential cost-savings of the order of as much as $10bn per year for the financial institutions participating in wholesale markets, provided that is that the LEI becomes the standard legal entity identifier in all aspects of customer business, including customer on-boarding, AML, and KYC compliance, as well as for regulatory purposes.

Standardisation of reporting of OTC derivative markets trades to trade repositories.

The G-20 at their 2009 Pittsburgh meeting agreed that one response to the global financial crisis was that all 'over the counter' (OTC) derivative trades should be reported to trade repositories, with the goal that this reporting would ensure that regulators would never again be caught unawares by a substantial build-up of derivative risk exposures with insufficient capital support (as happened in 2007-2008 when financial regulators around the world only realised too late that the scale of uncollateralized CDS protection written by AIG and a number of 'monoline' bond insurers).

In order for this reporting to trade repositories to be useful, it is necessary for the trade representation and reporting of events to be standardised so that information from different firms can be combined in a meaningful way. For a variety of reasons – including what appears to have been inconsistent and arbitrary regulatory decision-making – progress on developing these standards has been slow and the outcome,

despite substantial efforts by both practitioners and regulators, has been far from satisfactory.

One illustration of these problems is the following statement made in 2013 by then CFTC commissioner Scott O'Malia about the OTC derivative trade repository reporting required by the US Dodd-Frank Act:

> "Specifically, the data submitted to SDRs [swaps data repositories] and, in turn, to the Commission is not usable in its current form. The problem is so bad that staff have indicated that they currently cannot find the London Whale [a reference to the massive unauthorised trades on which JP Morgan had lost several billion dollars earlier in the year] in the current data files. Why is that?
>
> In a rush to promulgate the reporting rules, the Commission failed to specify the data format reporting parties must use when sending their swaps to SDRs. In other words, the Commission told the industry what information to report, but didn't specify which language to use. This has become a serious problem. As it turned out, each reporting party has its own internal nomenclature that is used to compile its swap data.
>
> The end result is that even when market participants submit the correct data to SDRs, the language received from each reporting party is different. In addition, data is being recorded inconsistently from one dealer to another. It means that for each category of swap identified by the 70+ reporting swap dealers, those swaps will be reported in 70+ different data formats because each swap dealer has its own proprietary data format it uses in its internal systems. Now multiply that number by the number of different fields the rules require market participants to report.
>
> To make matters worse, that's just the swap dealers; the same thing is going to happen when the Commission has major swap participants and end-users reporting. The permutations of data language are staggering. Doesn't that sound like a reporting nightmare?" (O'Malia 2013)

While this provides a graphic illustration of some of the problems involved, many practitioners view these problems in large part as having been created by the regulators themselves. We have for example heard claims that the US trade repositories were trying, inappropriately, to translate data supplied to them in flexible XML based formats into fixed field tabular structures which resulted in the loss of key information.

While we are unable to judge this particular claim, a clear illustration of regulatory shortcomings comes from the efforts to create Unique Global Identifiers: 1) a 'Unique swap identifier' (USI, as it is referred to by CFTC) or 'Unique trade identifier' (UTI, as it is referred to globally), and 2) 'Unique Product Identifier' (UPI).

An early decision in the implementation of reporting to trade repositories was a requirement that every OTC derivative trade be reported with an identifier unique to the particular trade (USI/ UTI) and also with unique identification of products (unique product identifiers or UPIs). The rationale for having a UTI has been recently summarised by the Financial Stability Board (Financial Stability Board 2014a) as "OTC derivative transactions may be reported to many different TRs and can, over their life, experience multiple amendments, notations and risk-mitigating exercises. If there is no standardisation, but instead different jurisdictions or different TRs use their own approaches, there could be problems in the areas of: (i) double counting if transactions are reported to different TRs; (ii) linking transactions when a life cycle event occurs and different events are reported to different TRs; and, (iii) difficulty in linking an original bilateral transaction to the resulting cleared transactions."

While this provides a reasonable justification for introducing a UTI, liaison and consultation with the industry on its development has been flawed. The outcome has been in effect several parallel systems for trade identification - the CFTC USI, the SEC UTI and the EU's UTI.[31] We briefly summarise how the work of regulators and industry has led to this rather unsatisfactory outcome.

Anticipating the requirement for USIs/UTIs, during 2010-2012 the industry trade body ISDA co-ordinated efforts amongst the major swaps dealers to develop a unique trade identifier for their reporting of derivative contracts to trade repositories as required by the 2010 US Dodd-Frank Act. The industry consensus was to use a combination of a namespace or prefix, uniquely identifying the party that assigns the TI; and a trade identifier component, unique within each assigning party. The combination of prefix and reporting party unique trade identifier would ensure a

[31] For further detail on industry work on UTIs & USIs see ISDA webpages: (ISDA n.d.)

global unique Trade Identifier. The proposal for the prefix was to leverage the LEI as a unique identifier.

This work however had to be set aside after the CFTC decision in early 2012 (a unilateral decision made without full consultation with the industry) that the construction of a USI or unique swaps identifier used in reporting to trade repositories would use a prefix that is linked to the registration requirement for CFTC reporting: Swap Dealers, Major Swap Participants are required to register with the b National Futures Association (NFA) and receive a 7 digit identifier as part of their registration. This identifier is completely detached from the global LEI standard and and is only available for parties that have a CFTC reporting requirement.

To construct the prefix, three initial characters, reserved for NFA, are added to the NFA id. The resulting 10 character prefix and the 32 character trade identifier together form the 42 character USI. As a result the CFTC USI identifiers are jurisdictional and not global, usable only in US markets by US-based institutions for US trade reporting.

This CFTC identifier is not unique, even within the United States. Securities based Swap Transactions are regulated by the Securities and Exchange Commission (SEC). The SEC has moved more slowly than the CFTC but has recently consulted on its own UTI. As pointed out by (ISDA 2014a) the SEC proposals could result in trades that are reported to both SEC and CFTC , being given two 'unique' trade identification numbers.

In Europe regulatory authorities have pursued their own further independent approaches to trade numbering. The EU European Markets Infrastructure Regulation requires reporting to trade repositories in the EU using a 52-charactert UTI (rather than the 42-character USI required by the CFTC). According to practitioners with whom we have discussed this identifier, the decisions of the European Securities & Markets Authority (ESMA) about the UTI have been characterised by a complex system of rules for construction and a lack of consultation with the industry. European practice is further complicated by the requirement (in contrast to the USA) that both client and dealer are separately responsible for the reporting of derivative

trades to repositories.[32] This raises a set of question around who generates the UTI and how the UTI is exchanged between parties before reporting takes place.

[

There is similar apparently unnecessary fragmentation and complexity in requirements for the provision of universal product identifiers (UPIs). The requirement for UPIs arose from a desire by regulators to mimic the exchange-traded world (where every contract has a unique identifier) in OTC trading. In the absence of any exchange this requires an agreed mapping from the details of the contract itself to generate a unique number. Anticipating this regulatory demand ISDA engaged in a substantial effort to create such a mapping, beginning with a *taxonomy* for OTC derivatives (for a description of the objectives of this taxonomy and its current state of development see (ISDA 2011; ISDA 2014b)) designed to ensure that contracts were described in a consistent manner, when implemented in FpML in different firms' systems, and hence allowing a unique product identifier (UPI) to be created.

Such a taxonomy is necessarily quite involved. For example, amongst credit derivatives ISDA distinguishes some thirty major contracts, such as the various iTraXX credit indices, the ABX index for mortgage-backed securities, and individual credit derivatives such as CDS and total return swaps. Similar level of detail is necessary for other derivative products based on fixed income, foreign exchange, equities and commodities.

While this ISDA-supported work on UPIs has not had to be set aside, unnecessary costs are being imposed because of lack of progress towards an agreed industry-wide solution. This is in part due to the variety of different underlying approaches to recording swap exposures.[33] ESMA has insisted on a relatively crude interim solution with a few basic contract characteristics (see (ESMA 2014)). The CFTC requires a UPI

[32] See (Milne & Parboteeah 2014) for discussion of some of the costs this has imposed on European firms.
[33] See interviews reported in (Milne & Parboteeah 2014) indicating that FpML is only one of several solutions used by industry for describing derivative contracts.

to be provided, but this can be any interim solution until such time as a global solution is developed. Global regulatory acceptance of such a UPI still seems some way off.

It is clear that the implementation of USIs/UTIs and UPIs has been unnecessarily burdensome on the industry and that absence of standardisation has been one reason for the difficulties faced in aggregating information on OTC derivatives in trade repositories. Following a Financial Stability Board consultation in 2014 (summarised in (Financial Stability Board 2014b)) the global regulatory community is now in early 2015 launching a project to establish global UTIs and UPIs.[34]

The eventual outcome remains unclear. It appears to us that one underlyuing factor contributing to this fragmentation of identifiers has been lack of clarity about intended usage. In the case of USI/UTI one intended usage is to avoid duplication where reporting is "two-sided" by both dealer and client, or to two separate trade repositories, but a much simpler identification system would have sufficed for his purpose (for example each trade repository could have its own numbering system and the requirement could have been simply to provide matching of the numbers for cases where a trade is reported twice).

Another possible reason is in order to link an original trade with subsequent risk modifications, for example a subsequent offsetting trade executed with the sole purpose of extinguishing the original trade, but here the regulators have not been working 'with the grain' of industry interests. It is clearly beneficial to firms to be able to consolidate their own exposures, but what is then needed is a common industry wide solution (perhaps using trade repositories as an information store) not reinventing separate solutions for firms and for regulators.

In the case of UPIs the need is presumably to allow functions such as computation of market exposures and sensitivities to risk factors. Here again overambition appears to be undermining regulatory objectives. For such aggregation purposes it is not

[34] Information on this initiative obtained from a recent workshop (Bank of England 2015). We have been unable to find any press release with a fuller description of this initiative.

necessary to have a complete system of product identification, what must be covered are major product classes. A broad “other” classification could reasonably be used in at least in some cases, providing a measure of the completeness of aggregation and indicating when there is a need for refinement of the identification scheme.

In short, it can be seen that post-crisis regulatory requirements for reporting in OTC derivative markets have made extensive demands on firms without keeping practical application in mind.. Instead the authorities have been pursuing what seems to have been a counterproductive one-time perfect solution for all circumstances, now and in future. As anyone with business experience recognises this is not usually the right way to develop an information system. Effective business information systems are built up slowly and incrementally, pursuing clearly stated and immediate practical objectives and learning the lessons from each stage of development. Identification schema need to be tailored to practical need, for example it is important to distinguish data fundamentals that cannot change during the life of a contract – such as identification of counterparty through the LEI – from investigative identifiers that may provide a convenient summary of the characteristics of what is being identified (such the UPI), and are always subject to improvement and refinement.

The regulatory community have so far largely failed in their work on standardisation in OTC derivative markets. Comparison with the limited and focused achievements made through the limited and focused development of the global LEI system show the great advantage of concentrating on immediate practical outcomes.

This failure has in turn contributed to the difficulties described by O’Malia in using the trade repository data. If some initial limited and specific applications of trade repository data had agreed before introducing the reporting systems, and the parties reporting OTC trades had a clear understanding of how the information they provide would be subsequently used, then there would have been less errors, greater conformity of expected field descriptions and some practical value would have already emerged from trade reporting. Instead, to date, this has been a costly and

burdensome exercise without any benefits for prudential safety or customer protection.

The BCBS principles for risk data aggregation

In 2013 the Basel Committee on Banking Supervision announced principles for risk data aggregation (BCBS 2013a). This document is a wide-ranging list of eleven principles and forty-eight sub-principles (component paragraphs) stating the requirements that banks should be expected to meet for: (a) data governance and infrastructure; (b) what are described by the BCBS as risk aggregation 'capabilities' (i.e. the coverage and quality of reported risk measures) and (c) the reporting of risk both internally and externally. A further three principles and twelve sub-principles cover the powers of oversight and control that bank supervisors should have over a bank's risk reporting systems.

To give one example of the style of BCBS239, principle 3 paragraphs 36-40 describes the first of four 'capability' principles, stated as follows ((BCBS 2013a) pgs 8-9):

> Principle 3. Accuracy and Integrity – A bank should be able to generate accurate and reliable risk data to meet normal and stress/crisis reporting accuracy requirements. Data should be aggregated on a largely automated basis so as to minimise the probability of errors.
>
> 36. A bank should aggregate risk data in a way that is accurate and reliable.
>
> (a) Controls surrounding risk data should be as robust as those applicable to accounting data.
>
> (b) Where a bank relies on manual processes and desktop applications (eg spreadsheets, databases) and has specific risk units that use these applications for software development, it should have effective mitigants in place (eg end-user computing policies and procedures) and other effective controls that are consistently applied across the bank's processes.
>
> (c) Risk data should be reconciled with bank's sources, including accounting data where appropriate, to ensure that the risk data is accurate.
>
> (d) A bank should strive towards a single authoritative source for risk data per each type of risk.

(e) A bank's risk personnel should have sufficient access to risk data to ensure they can appropriately aggregate, validate and reconcile the data to risk reports.

37. As a precondition, a bank should have a "dictionary" of the concepts used, such that data is defined consistently across an organisation.

38. There should be an appropriate balance between automated and manual systems. Where professional judgements are required, human intervention may be appropriate. For many other processes, a higher degree of automation is desirable to reduce the risk of errors.

39. Supervisors expect banks to document and explain all of their risk data aggregation processes whether automated or manual (judgement based or otherwise). Documentation should include an explanation of the appropriateness of any manual workarounds, a description of their criticality to the accuracy of risk data aggregation and proposed actions to reduce the impact.

40. Supervisors expect banks to measure and monitor the accuracy of data and to develop appropriate escalation channels and action plans to be in place to rectify poor data quality.

The BCBS has issued other statements of the principles in the past. The best known are the BCBS core principles for effective banking supervision, originally published in 1997 and since revised several times, most recently in 2012 (see (BCBS n.d.)) These principles of effective bank supervision have been a useful conceptual framework for helping bank supervisors around the world assess what they do and the effectiveness of their own work. BCBS239 is similar in that it provides a framework (a check list) that supervisors can use to assess the effectiveness with which individual firms collect, store and manipulate risk data. But as this extract makes clear, BCBS239 does *not* propose industry *standards* that will be used for carrying out these functions, either technical standards for data reporting or business process and quality standards framework that can be used by firms or vendors for certification of adherence to these principles.

(Chisholm 2014) assesses these BCBS239 requirements, finding that they pose an immense challenge to banks' abilities to manage data across multiple systems and jurisdictions. The challenge is not technological but methodological: for firms to achieve fully the principles of BCBS239 they cannot rely simply on technology spend. Achieving the level of data management capacity stated in BCBS239 will require

firms to review fully and almost entirely reconstitute their methods for the recording and aggregation of business data.

Firms have expressed considerable concerns about the demands this places on their IT budgets and operational staff. The BCBS has insisted, after consultation, that "Firms designated as global systemically-important banks (G-SIBs) are required to implement the Principles in full by the beginning of 2016" ((BCBS 2013b)). Nonetheless it remains unclear what banks actually need to do by this deadline. The phrase 'implement a principle' is open to an extremely wide range of interpretation. These principles are not precise statements of business process i.e. they are not standards.

In practice, according to several reports in the trade press, it appears that in order to "implement the Principles in full" all that is actually required is that firms demonstrate to supervisors some progress towards improving their data systems according to the range of assessment criteria set out in BCBS239.

The pace of progress will inevitably be slow, limited by IT budgets that are already being stretched by other regulatory demands including those already discussed above for the reporting and clearing of OTC derivatives (for some evidence of this see the interviews reported in (Milne & Parboteeah 2014)).

These high costs and slow pace of progress are aggravated by the absence of standards for recording data. Every bank is seeking to follow the BCBS239 principles in its own way. To the extent that there is any common approach this comes from leading consultancies and technology vendors providing solutions to BCBS239 that are then taken up by a number of their client-banks.

It is questionable if, without common cross industry standards for recording and manipulation of data, banks will ever come close to achieving the data aggregation capacity envisaged by BCBS239. The required costs of overhauling their data systems (as identified by (Chisholm 2014)) are likely to be prohibitively costly for any individual firm. Industry-wide co-operation on the design and development of data standards is therefore essential if the capacity for data aggregation is to be

significantly improved and it is quite surprising that the role of standards is not even mentioned in BCBS239.

Work on data standards (for example that on FIBO of the Enterprise Data Management Council described in the next subsection) is taking place, and may eventually support the necessary transformation of underlying data systems. But this is clearly going to take well beyond the artificial BCBS239 deadline of January 2016 (it took more than three years to create the much more limited standard embodied in the Global LEI System).

We perceive a similar failing in BCBS239 as that which has weakened OTC derivative trade reporting, a failure to pay attention to the details of practical implementation, including the development of specific standards for recording of data at a granular level and the extent to which with the interests of firms can be harnessed to develop such standards and embed them across the industry. We also note the absence of any developed framework (a business process standard) for certification of compliance with the Basel principles. It is unclear for example why the Basel Committee has not used their document as an input to an ISO standard which could be self monitored by firms (seeking to demonstrate the quality of their data management to investors) and so relieving regulators of the burden of checking data quality systems.

That said, BCBS239 has been a catalyst, encouraging many firms to improve their data management. The Enterprise Data Management council (see below for discussion of their related work on FIBO) has been prominent in this area, from 2005 engaged in documenting the practice and capabilities of data management, confirm capabilities of data management. Their Data Management Capabilties model is 50 page documentation and scoring model .

Contract description and data standards: FIBO and ACTUS

While standards for financial transaction and payments messaging are fairly well developed, there has been less progress on developing common standards for describing data and financial contracts. Different approaches are used in different jurisdictions or by different firms. Even within jurisdictions and within firms,

standards remain fragmented. A common situation, for example, is for a firm to run several different operational systems, introduced as a result of the acquisition of other firms, for the same product or customer process. The perceived business benefits of shifting onto a single standard system are typically too small to justify the expense of standardising on a common business process across the firm.[35]

It is however widely recognised that standardisation of contract specifications and data descriptions can be of immense benefit to industry, thereby reducing the costs of complying with current regulatory demands (as described in the previous sub-section), improving processing efficiency and reducing risk both for individual firms and the industry as a whole. This section describes two initiatives that seek to support such standardisation.

The Financial Industry Business Ontology (FIBO) is a collaborative effort over the past decade that seeks to standardise: (i) the language used to define terms, conditions and characteristics of financial instruments; (ii) the legal and relationship structure of business entities; (iii) the content and time dimensions of market data; and (iv) the legal obligations and process aspects of corporate actions (EDM FIBO Website, 2014).

FIBO is being developed under the auspices of the Enterprise Data Management Council (EDM council) whose members consist of many of the world's largest global banks. The experts collaborating on the project include industry practitioners, technology experts, semantics experts and information scientists. The Enterprise Data Management Council describes FIBO as an *ontology*, i.e. a statement of unambiguous, shared meaning of key terms and the relationship between them that can support automated computer processing. They are developing description of 30 "top level" domains (to date 25 are completely modelled), each one a process (e.g. corporate action) or instrument (e.g. interest rate swap, equity, mortgage backed security).[36] These are conceptual models, not *semantic* but a statement of common meaning with accompanying definitions of 'things' and statement of relations between 'things'.

[35] For examples see the interviews with data professionals reported in (Chan & Milne 2013)
[36] See (Bennett 2013).

The description of these domains are then be carried forward into the second level, with each now being expressed in OWL2, the latest version of the RDF/XML-based 'web ontology language' developed by W3C as a tool for supporting automated processing of data from the World Wide Web. This may involve several OWL ontologies within each of the thirty top level domains (equities, versus preferred shares etc.)

Creating such an ontology that can be used by all participants in the financial industry would offers several potential benefits including enabling a common reference standard for aligning data repositories and improving internal and external communication (see above Section 3 for further discussion of ontologies and their role in automated processing of information on the Semantic Web). SThe ultimate goal of allowing automated processing of data with minimal need for human–computer interaction.

FIBO is thus an ambitious undertaking that seeks, ultimately, to provide a single common language for all aspects of finance. It is though inevitably a work in progress.[37] The Enterprise Data Management Council itself recognises the scale of the challenge and acknowledges that those parts of the FIBO ontology that focus on definition of concepts will be more complete that those parts that deal with specific business applications. Thus Mike Bennett writes:

> *"Therefore there is an important distinction to be made between two types of FIBO ontology, even when these are both expressed in OWL:*
>
> - *The FIBO Business Conceptual Ontology - fully legally and conceptually grounded model which unambiguously defines the meanings of terms;*
> - *Operational Ontologies: individual RDF/OWL applications for one or more specific use cases, implemented according to the design constraints which are appropriate for a given semantic technology application.*

[37] Reservations include the feasibility of ever obtaining a single such common language (Milne & Chisholm 2013) and whether, the scope of FIBO is too broad to be maintained as a practically useful ontology (see (Hepp 2008) for contrast between narrow and broad ontologies).

> *For some use cases, such as for querying over large sets of data in big data stores or across multiple conventional technology silos, it may be that the operational ontology is substantially the same as, or a significant portion of, the Business Conceptual Ontology. For other use cases, operational ontologies may be very much smaller."* (Bennett 2013)

Another initiative is ACTUS. This project, housed at the Stevens Institute of Technology in New Jersey but working with collaborators worldwide, has a narrower focused on developing standard algorithmic descriptions of financial contracts (ACTUS is an acronym for 'Algorithmic Contract Types Unified Standards').

ACTUS has been developed from the conceptual description of contractual cash flows and risk exposures set out in (Brammertz et al. 2009). This describes the impact of changes in risk factors on the cash flow obligations of a financial contract – i.e. how underlying financial contracts determine so called 'state-contingent cash flows'.

As described on the ACTUS web pages (ACTUS 2014), "The goal of this project is to build a financial instrument reference database that represents virtually all financial contracts as algorithms that link changes in risk factors (market risk, credit risk, and behaviour, etc.) to cash-flow obligations of financial contracts.". With the support of the Alfred P. Sloan foundation, the project is now developing detailed definitions of contract types, according to a limited set of attributes, that can represent virtually every standard contract in all the different asset classes (bonds, annuity loans, equities and also derivatives such as swaps and options). The ACTUS web page also offers open source software (Java, MYSQL data be, R programming) to conduct risk calculations based on these ACTUS contract types.

The rationale for the ACTUS project is that, beneath the plethora of different reference data standards in financial services, there is a great deal of commonality in the 'contract space', in the contracts themselves (loans, deposits, securities, derivatives) and in the operational systems used to deliver the resulting contractual obligations (interest, coupon and dividend payments, principal repayments, option exercise, etc). ACTUS estimates that a very large proportion of global financial contracts – approaching 99% by notional value – can already be algorithmically

represented in the ACTUS reference data base. This initiative is now attracting increasing external interest, especially from regulators who perceive an opportunity to obtain regulatory reporting that enables comparison across institutions, through firms using the ACTUS reference framework.

The FIBO and ACTUS initiatives are complementary. A clear understanding of financial concepts and their business context, of the kind that FIBO is seeking to develop, is a starting point for any machine-based processing of financial data. Consistency of analytics – for different firms, jurisdictions and time periods – requires in addition an unambiguous and precise mapping of risk and market situations (e.g. market pricing data) into contractual cash flows i.e. a standardised processing of contractual outcomes based on underlying contracts as is provided by ACTUS.

But while these initiatives hold much promise, there is a considerable amount of effort still required to evaluate exactly how they can be made to work together in practical terms.

- ACTUS offers a consistent architecture for efficient data and business processing across most of financial services. Widely adopted, it has the potential to reduce substantially processing and information costs across the industry; but this may require substantial reengineering of existing processes (ACTUS itself does not think that substantial re-engineering is needed to apply its framework, but this needs further practical demonstration).

- FIBO has the attraction of not requiring any alteration in the business processes used by individual firms: rather it seeks to use 'semantic web' concepts to support an effective integration and aggregation of information both within firms and at industry level. A concern is that FIBO must cover such a wide range of different business processes that it may struggle to deliver the effective aggregation that it is sought to achieve.

Neither provides a single 'out-of-the-box' solution to data aggregation and processing that can be applied directly across the full range of financial activities.

Instead a substantial and co-ordinated effort is needed to establish standard practice for risk and data aggregation, product by product and business line by business line. At each stage the contributions of FIBO, ACTUS and other potential aggregation solutions will have to be assessed and a workable common approach established.

The insufficient global governance of financial market standards

We complete this section with a review of global governance arrangements for financial market standards, critically comparing with those in other industries, and assessing the extent to which these are effective in overcoming market failure in the development and adoption of standards and in responding to the demanding post-crisis regulatory agenda. We argue that these global governance arrangements are insufficiently developed and this has imposed unnecessary costs on industry from post-crisis regulatory reporting requirements.

A principal institution for international governance of standards in financial services is the International Organization for Standardization's Technical Committee 68 (ISO/TC68) (one of the original ISO committees dating back to the establishment of ISO in 1948). ISO/TC68 is designated to develop standards and technical reports for the financial services businesses and transactions (ISO/TC68 Business Plan, 2012). This includes a range of institutions and activities, from non-deposit or finance companies to lenders (consumer and commercial) and buy- and sell-side firms in securities markets, amongst others.

The business plan for ISO/TC68 has a number of priorities, including:

- First and foremost, get better at standards promotion and awareness
- Must demonstrate that standards create value by enabling the success of business initiatives, solving real business issues and problems
- Must fulfil the needs of users, not the perceived needs of professional standardizers
- Must be able to respond quickly to business and market changes
- Must stay relevant to the businesses and markets that they support

- Must be inclusive, allow the contributions and feedback of stakeholders and users to be included in the standards development and revision processes
- Must be international in scope and internationally accepted
- Must have continued access to, availability and participation of the necessary technical and subject matter experts as standards development is a voluntary effort
- Must attract new participants and stakeholders to the standards development process
- Those promoting, developing and using standards must maintain, and increase, collaboration among stakeholder and industry players
- Must factor in resistance to implementation – competing priorities, existence of legacy, coexistence with other standards (including other ISO standards)
- Must improve the perception of the global financial services industry
- Must factor sustainability into the standards development process.

(ISO 2012)

ISO/TC68 organises its work through different subcommittees and working groups and most of the standards developed by ISO/TC68 are adopted by member countries, for example in the case of the UK via BSI and the UK Payments Council. As ISO notes, its coexistence with other standards and standards bodies must be checked carefully. It recommends that where standards conflict, or even overlap, consensus need to be reached on an efficient way forward. Importantly, ISO/TC68 also recognises the importance of staying "close to the needs of market players and other users".

Reflecting the federated structure of ISO, there are a number of corresponding national and regional standards bodies, covering financial services and providing input into ISO/TC68. For example in the UK the corresponding standards committee is BSI Committee: IST/12 covering financial services (see (BSI n.d.)).

ISO/TC68 is an effective co-ordinating body (for example in its development of both the ISO 20022 standard and more recently in the development of ISO 17442, which defines the standard for the global Legal Entity Identifier). It has though a very wide

range of responsibilities, across all retail and customer products as well as financial markets, and most importantly, like other ISO technical committees, it is limited in what it can do because it cannot initiate new initiatives - rather it must respond to requests.

The individual standards bodies operating in financial market that we have reviewed in this paper – FIX, ISDA/FpML, ISO and others – all do valuable work , but they are limited both by the specific nature of the standards for which they are responsible, and equally (in our observation) by a culture of 'volunteerism' in financial market standard-setting. Work on standards is regarded as an optional extra, worthy voluntary work that financial market professionals do in their spare time, largely in evenings and over weekends, and always outside of the day-job of running operational, data and transaction systems is completed.

There are also shortcomings on the regulatory side. Regulators have a key role to play in standardisation. Regulatory mandate can be a critical factor to achieving standardisation. The global LEI system, while taking an unexpectedly long time to develop, demonstrates how regulatory mandate can create a standard (in that case for legal entity identification) where private sector voluntary initiatives have failed. We have noted how initiatives by both US and Austrian regulators have improved domestic standards for recording of risk exposures.

Our review has however uncovered serious failings in relation to regulatory involvement in standards and standards development. This is apparent both in regulatory reporting for OTC derivative markets (where substantial and unnecessary burdens have been placed on industry because regulators have not worked with industry to create appropriate supporting standards) and in the failure to promote standardisation as a means to achieving the improved capacity for risk aggregation sought by the BCBS in the principles stated in BCBS239 (again imposing large and unnecessary costs on industry).

In particular we find that regulators have paid insufficient attention to standardisation of both business and regulatory process. The substantial and unnecessary costs of both OTC reporting and the BCBS239 process are, in large part,

because regulatory requirements have been stated in vague and general terms without a clear relationship to either underlying business activities or subsequent use by regulators.

To summarise: greater standardisation in global financial markets offers very substantial benefits – in terms of lower costs, greater operation efficiency, improved risk management and safety of the financial system as a whole. But lack of co-ordination and lack of attention to standards has meant that both industry *and* regulators are failing to take sufficient and effective steps to promote standards and standards development.

In contrast to the electrical engineering and technology industries, there is no professional body that supports standards and standards development. Unlike GS1 in the global supply chain there is no single specialised industry institution for the development and support of standards in financial markets. A culture of supporting interoperability and openness is not deeply rooted in financial markets in the same way as it is in the internet and the World Wide Web (such a culture is not absent from wholesale financial markets: the many individuals involved in standards-setting in wholesale financial markets would not otherwise devote so much of their spare time to promoting standardisation, but it is not supported at senior level by either firm managers or regulators.) The formal standards-setting bodies, such as ISO, have no remit to develop and improve the attitudes towards standardisation in the global financial markets.

Figure 3 indicates one possible institutional structure for promoting standard setting in global financial markets. The novel feature here, something that does not exist at all today, is the "The Financial Service Global Standards Forum", the oval figure on the top right of the diagram. At present there is no established institutional arrangement for discussion of standards between regulators and industry. This means there is no permanently established arrangements conducting the necessary preliminary work before the process of creating a formal standard in financial services. A new body like this, engaged with the senior level of management both in the industry and regulators, could identify opportunities for standardisation and ensure that there is an adequate dialogue

about proposed standardisations. It could moreover identify where there is an alignment of interest between industry and the authorities so that standardisation can proceed on a voluntary basis and where interests are not fully aligned and so regulatory mandate may be appropriate.

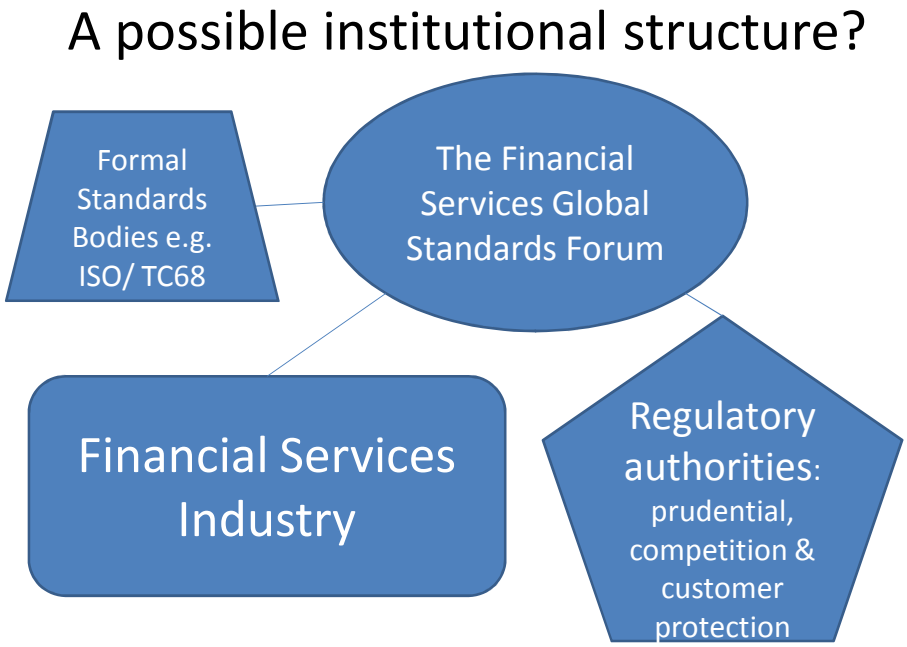


Figure 3: A possible institutional structure to promote standard setting in global financial markets

Figure 3 is clearly far from complete. In practice many opportunities for standardisation will be pursued at national or regional rather than on a global basis. This Financial Services Global Standards Forum might need to have a federated structure (similar to that of GS1 or ISO) with component bodies promoting coordination and dialogue on standard setting at national and regional level.

Another gap is that this figure does not specify the relationship with existing global regulatory institutions, such as the Bank for International Settlements, the various global committees such as the Basel Committee on Banking Supervision and the Financial Stability Board. One possibility is that this body is created as a further international regulatory body, but this could undermine the goal of promoting partnership and dialogue on standard setting between industry and

regulators. Arrangements could be modelled, to a degree, on those found in other industries (such as the IEEE or the Internet Task Force); but financial regulators will surely insist that they have some formally established role in any global standards forum , so there cannot be an exact parallel with arrangements in other industries.

The ultimate goals may be such an overarching body for governance of standards in global financial markets providing oversight of both regulatory and industry activities. But consensus on the need for such a body will only be estabilished through demonstration that such co-operation can support effective practical action. In the immediate future this can be pursued through improved informal arrangements for dialogue and communication on standards-setting, involving both regulators and the industry at the most senior level.

5. Conclusion and proposals for action

Conclusion

The main conclusion from this review is the underdevelopment of standards-setting institutions in financial services, especially when comparing with arrangements for other industries described in Section 3.

The internet has both the Internet Society – setting standards for internet as a whole – and W3C – setting standards for web page resources. In electronic and electrical engineering another professional membership body, the IEEE, takes a leading role in standards development. In retail, supply chain and healthcare there is GS1 which has been able to co-ordinate and develop identification and communication standards in response to stakeholder needs.

In global financial markets there is no overarching body playing a role in standards-setting, like that played by the Internet Society and W3C, the IEEE or to GS1. There are co-operative arrangements for standard setting (we have reviewed the work of the FIX Protocol Ltd, of SWIFT and of ISDA in transaction messaging) but, while these (like GS1) are not for profit and owned by a number of corporate members, they activities do not cover the entire industry and their activities are limited to particular aspects of financial transactions, mostly in trade execution, payments and settlement instructions.

The consequence is that financial standards in global financial markets lack leadership. Instead of the professionalization of standards development found in some other industries, what has emerged in global financial markets is something of a something of plethora of standards, but with excessive fragmentation in many areas and lack of coverage in others. A small number of dedicated professionals do seek to fill this vacuum, in the transactions space and more recently in reference data and contract definitions. But these efforts are fragmented and in danger of being overwhelmed by the increasing demands of regulatory reporting and compliance.

This perception is supported by the views put forward at the July 2013 workshop which initiated this project. Admittedly this was an audience composed of practitioners working largely part-time on standards-setting and therefore predisposed to the view that standards-setting in global financial markets requires more resources and attention. Still, much of the discussion at that meeting is consonant with our own analysis and conclusions about the shortcomings of the governance and the need for strategic development of standards in global financial markets.

Amongst the points made at that meeting were the following (these comments are freely adapted from the unpublished meeting record taken by the Government Office for Science).

- Weak governance of the policy and strategy aspects of standards and a fixation on solving short-term technical difficulties. Although there is a focus on meeting immediate technical challenges, as a business necessity, this can divert attention from longer-term issues.

- Insufficient private benefits to adopting a standard, not related to broader societal benefits. Also difficulty in judging when to adopt a standard, due in part to lack of clear leadership and co-ordination. Thus adoption tends to be insufficient and there are strong incentives for free-riding on standards development and subsequent standards maintenance.

- Under-funding the development of a standards, perceived as being a clear problem in financial services. Also coordination has been difficult to achieve, in contrast to other industries: for example progress on establishing a global legal entity identifier has, in the end through the global LEI system, required regulatory mandate.

- At the same time, while it is understood that standards should always be in the public interest, regulators (with the exception of the global LEI initiative) have generally been rather passive in terms of engaging with, driving definition of, promoting and enforcing standards

These points are consistent with the picture we have drawn of an insufficiently developed institutional framework, compared to other industries, for the strategic development and appropriate governance of standards in global financial markets.

Future Actions

We conclude with a brief statement of actions that we believe should to be taken in order to support standardisation in global financial markets.

First, we emphasise the point that most effective action on standards is driven by perceived practical needs. The immediate motivation for our own project was the concern expressed in the UK Government Foresight Report (Government Office for Science 2012) that standards development was falling behind the rapid pace of technological change in equity and other financial market trading. But this is reinforced by the challenging data problems that have emerged with the requirements for reporting of OTC trades to trade repositories in the US Dodd-Frank Act and in the EU European Markets Infrastructure Regulation and by the pressing requirements of BCBS239 principles of effective risk data aggregation. More discussion and dialogue is needed involving both industry and regulators and incorporating a range of views from universities, independent experts and others to identify these needs and ensure appropriate response.

In particular we urge the need for detailed review and examination of specific opportunities for standards development, supported by an appropriate dialogue between industry and regulators. Such opportunities are clearly present in transaction and messaging standards (because transactions and messaging can always be improved through co-operation between firms), but are also found in other aspects of business, for example in the recording and aggregation of data.

We also suggest that it may be necessary to create new institutional arrangements at global, regional and national level, to promote this dialogue and co-ordination of the development of standards, both across the industry and between industry and regulatory authorities. We are not in a position to make complete recommendations, but we have provided an indication of what such institutional arrangements might look like (our Figure 3 above).

Second, we perceive a need for much greater involvement of senior management, at board level, from the major financial institutions, in particular the major investment funds with the most obvious gains from the cost reductions that can be unlocked through greater standardisation; and also engagement at an equivalent senior level from the principal regulatory institutions. Standardisation needs to be more widely recognised as a board-level strategic issue, to promote the safety and efficient operation of global financial markets.[38]

We hope that with board-level engagement will be a consensus on building more fully-developed institutional arrangements for governing the development and maintenance of standards for global financial markets. A first step towards improved institutional arrangements could be the establishment of more informal arrangements for dialogue and communication on standards-setting, endorsed by both regulators and the industry at the most senior level.

Third, we would like to see a renewed effort, by researchers and practitioners, on identifying specific opportunities for using standardisation to promote business efficiency and improve market transparency. Such identification is a necessary precursor to practical steps on standards development e.g. through a process of formal standard creation, imposition of a regulatory mandate or simply by agreement amongst market participants.

[38] Here we echo the views on standardisation put forward by (Mainelli & von Gunten 2013)

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