Sustainable Financial Services in the Digital Age

UK FINANCE

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Acknowledgements and contacts

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Foreword

The advent of a digital economy is reshaping all aspects of our everyday lives. Such is the creative destruction of digital technology that it has been referred to as 'the fourth industrial revolution' by Klaus Schwab, the founder of the World Economic Forum. The hallmarks of this revolution include a new generation of smart and connected devices, the so-called Internet of Things (IoT) powered by the Cloud, accompanied by innovations in driverless vehicles, artificial intelligence, augmented reality and the blockchain. Tomorrow's world will look very different to what went before.

Far from being immune to this process of rapid change, financial services can expect to take centre stage with the emergence of a variety of new operating models. This recognises that competing on existing services is not sufficient. In the future, customer relationships will become more personalised, frictionless and forward-looking in helping households and businesses address all their complex and evolving financial challenges. Whether this results in a revolutionary 'Uber' moment, or a period of slower evolution, remains to be seen. Either way, a new type of financial services company is already emerging.

We have witnessed a major transformation from a business model based on manual processes and branch networks, to the current multi-channel businesses. After an extended period of lower global economic growth and lower investment yields, financial services companies are having to think creatively to develop new, more efficient business models, capable of meeting rapidly changing client expectations with new products and services. Companies will also need to adapt to a changing marketplace, characterised by increased competition, as well as collaboration with 'disruptive' technology firms and new challenger brands.

We live in an innovative and rapidly evolving landscape, one which yields undoubted benefits for shareholders and customers alike. But the speed and scale of digital transformation also bring with it a whole series of emerging risks across all business functions. Data-driven business models will require not only new business processes, but also new skill sets and a new, more agile and adaptable business culture, while ensuring data security at all times. The growth of digital outsourcing via the Cloud, whether it is in the shape of digital platforms or infrastructure, software or data, means that these emerging risks are also becoming more ingrained within the business supply chain.

The challenges associated with these risks are not insurmountable. But they do require new ways of working and thinking. The onus is increasingly on senior managers to find new ways of identifying and managing non-financial risks, while regulators must find new ways to supervise firms in ways which meet their statutory requirements, to protect consumers and maintain stable and orderly markets, while fostering technological innovation.

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Executive Summary

Achieving Sustainable Digital Financial Services

In performing its core functions of deposit-taking and credit creation, as well as maintaining the infrastructure for payment systems which enable frictionless transactions between households and businesses, the financial system acts as an intermediary without which no economy would be able to function. The way financial firms operate has a massive impact not just at a micro level on individual consumers and businesses, but also on a macro level on the stability of the whole financial system and the wider economy.

Digitisation is rapidly changing the market landscape, and with it, the way in which financial firms operate. This brings new opportunities to reshape customer products and services through a more diverse and competitive banking ecosystem made up of both incumbent and challenger brands. It also creates opportunities to develop new platforms and market infrastructure which could fundamentally reshape the cost economics of financial intermediation over time, securing massive cost benefits for all users of financial services. The adoption of digital technology means that a more efficient financial sector is already emerging which can deliver products and services more quickly and at a lower cost.

Digital innovation, however, brings non-financial risks to the fore. The increasing reliance on key technologies to improve customer experience to drive operational efficiency has heightened the industry's vulnerabilities to cyber-attacks and technology-related risks. Enabling technologies such as the Cloud, Artificial Intelligence (AI) and Distributed Ledger Technology (DLT) are transforming business models, challenging the risk functions and the regulatory frameworks' ability to respond. Left unaddressed, this will lead to uncertainty and ambiguity that will be a drag on innovation and introduce new risks to the industry.

Opportunities and risks brought about by fintech also call for a rethink of financial regulations. The Basel Committee on Banking Supervision (BCBS) and the Financial Stability Board (FSB) have both published reports highlighting the regulatory shift to focusing on issues including technology risk, cybersecurity, data privacy and digital conduct in the financial industry. The BCBS, in particular, said in a report exploring sound practices of fintech supervision that financial firms will find it increasingly difficult to maintain their current operating models in light of the technological upheaval.

Three key technologies were identified by the BCBS as the "catalyst that allows for the development of new innovative products and for fintech companies to enter the banking markets".[1] These will be the focus of this report – in each domain, we explore the industry's plans for technology use and their implications on the risk agenda.

Artificial Intelligence and Machine Learning

- AI and predictive analytics are having a profound impact on how firms model risk within their business and are therefore helping to shift the business management lens from historic to forward-looking. The benefits extend to improving the effectiveness of Know your customer (KYC), regulatory reporting, anti-money laundering and fraud detection, customer service, complaints handling and cyber resilience.
- The successful adoption of AI will require a new mindset for both firms and regulators. Protecting and growing the financial market with AI requires stronger assessment of AI and machine learning in view of their risks, including adherence to new protocols on data privacy, conduct risks, and cybersecurity.

[1] Basel Committee on Banking Supervision, "Sound Practices: implications of FinTech developments for banks and bank supervisors", February 2018, p.30

Artificial Intelligence and Machine Learning continued...

- The validation of models that 'self-build' (for example genetic applications for credit scoring), predictive analytic models that are opaque (for example neural networks) and automated advisory models that could be prone to inadvertent mis-selling, would all benefit from best practice principles and guidelines to reduce ambiguity in this area. Adequate testing and 'training' of tools with unbiased data and feedback mechanisms will also be key, so will the build-up of skills in-house to understand and supervise AI and machine learning models.

Migrating a Regulated Industry into the Cloud

- There are many benefits of building financial services applications in the Cloud, including faster time to market, lower development costs, expanded testing, enhanced controls, automatic scaling and failover, and quicker provisioning.
- However, these benefits, as well as the corresponding potential ubiquity of cloud computing across financial services, have contributed to the greater focus on operational and IT risk on the part of regulators and firms. As we discuss in this report, a market dominated by three large Cloud Service Providers (CSPs) gives rise to particular concerns surrounding market concentration risks.
- Many of the complicated questions raised by this relatively new technology - both for regulators and policymakers - are yet to be addressed. We recommend that jurisdictions across Europe emulate the approach of the European Commission and make the adoption of cloud computing across sectors, including financial services, a priority for securing future economic growth and prosperity.

Distributed Ledger Technology

- After a century in which the costs of financial intermediation have remained largely unchanged, DLT could now be a game changer for the industry. It has the potential to lower costs, reduce collateral and capital requirements, reduce the need for intermediation and streamline key elements of the banking operating model.
- As innovative technology providers play an increasingly important role in providing and maintaining financial market infrastructure (FMI), regulators need to ensure that market critical operations and services are maintained against a whole host of risks including systemic, legal, liquidity and credit risks, insolvency, and general business operational risks.
- There appears to be a growing consensus that the definition of best practice should be led by the industry but supported by the regulator, in line with their guiding principles. If this intent is followed through in practice by regulators and industry groups, then an environment is well-placed to emerge that can liberate the innovative and exciting potential of distributed ledgers.

A call for action

Regardless of whether banking is done in the branch or on an app, whether mortgage decisions are made by people or machines and whether assets are settled in a clearing house or on a distributed ledger, the goals of promoting market efficiency, reducing systemic risk, achieving fair customer outcomes and of supporting the wider economy remain shared by the industry, its regulators and policymakers.

Throughout this report we propose actions for financial firms, regulators and policymakers to address the evolving risk landscape that brings non-financial risks to the fore:

- Close the gap between incumbents' digital aspirations and the reality of legacy IT estates. No-regret moves include reducing reliance on legacy systems; de-cluttering and decommissioning redundant systems; and using analytics to provide modelling on key operational risks. Launching an entirely new, digital entity alongside the legacy organisation may also be necessary.
- Enhance governance structure and adapt risk frameworks to ensure that new technologies are integrated safely within operating models and new risks, and threat vectors arising from cyber and technology risk are taken account of.
- Review the integrity of fintech 'component solutions' being integrated into the supply chain. Key issues fintech firms can be susceptible to include: limited financial resources, development centres in remote or unregulated locations, and the lack of effective recovery options.
- Developing new risk taxonomies collaboratively with both the technology suppliers and regulatory community. This process should consider both how to achieve a consistent treatment internationally and also how capital charges could be evolved to place a greater emphasis on the effective management of technology and cyber risks.

It is only through all stakeholders – firms, policymakers and regulators – working together, sharing data and intelligence and developing guidelines that we can hope to deliver the benefits of digital transformation in a truly sustainable manner.

Introduction – Drivers of digitisation and the changing nature of risk

Digital innovation represents the most fundamental shift in the financial services operating model since the dawn of the electronic age. The ability to process ever greater amounts of data, and at ever greater speeds, has opened new horizons in how financial services firms operate and the range of products and services they are able to offer their customers. But it has also exposed firms to a growing range of non-financial risks, which have significant implications on how they develop and maintain their IT estate, and ultimately service their customers.

Drivers of digital financial services

Digitisation in financial services must seek to do more than distribute products and services to customers through a digital channel. It must also involve leveraging the combined power of new technologies, matured in a variety of sectors, to understand customers, transform and automate processes, deliver services and better manage their risks. The financial firm of the future should be one where agility and efficiency of the machine complements the creativity and judgement of human interventions, to truly enrich customer experience.

From this perspective, meeting consumers' changing needs while driving efficiencies have proven to be two particularly potent drivers of digitisation. In an increasingly digital world, customers want convenience and choice and they want it 'on demand'. Smart phone penetration, the predominant channel for digital retail financial services, has now exceeded 70 per cent in the mature markets, while high street branches in developed countries around the world are increasingly being 're-purposed' to complement the digital product offerings.[2] While consumers may be in the driving seat, cost pressures are also shaping the speed of change in financial services. This challenge is not limited to any one jurisdiction.

Similar low returns, compared to the cost of equity, are resulting in suppressed shareholder value across many countries.[3] It has been estimated that to achieve a one per cent improvement in return on regulatory capital would require a firm to achieve some combination of reducing the ratio of non-performing loans by 2.5 per cent, increasing net interest margins by 25 basis points and reducing the cost income ratio by 25 per cent.[4] That is a very challenging ask of any board and has become a key driver for exploring just how far and how quickly digitised processes and services can reduce the operational cost base.

Digitisation is not just a change to systems and processes; truly sustainable digital transformation also requires a change of culture. The culture shift needs to extend from the leadership and the digital innovation teams to all parts of the firm's operations and to their key stakeholders, internally and externally. This includes the risk and compliance functions of financial firms to safeguard the digital transformation, and the regulatory community to address the changing market and consumer demand.

2x

Growth in the volume of data expected every three years.

Source: McKinsey

2 Pew Research Centre, Mobile Fact Sheet, 12 January 2017.

3 European Central Bank data.

4 KPMG, The Profitability of EU Banks: Hard Work or a Lost Cause, October 2016.

The Changing Relationship of fintech Challengers and Incumbents: From Collaboration to Competition?

Financial services companies are faced with a dual challenge: how to access and integrate technological innovation within the existing business model and – given that this is often achieved via third-party relationships with fintech partners – how to achieve this goal while retaining control of the end customer relationship. Currently, major financial services companies typically view the fintech community as a helpful addition to the research landscape rather than a threat to their business. Between 2010 and 2015 the share of fintech investment directed at collaborative ventures in New York City more than doubled, from 37 per cent to 83 per cent.[5] This dynamic based on collaboration may well give way to a more competitive relationship in future. Large tech firms such as the 'GAFA' (Google, Apple, Facebook and Amazon) have well-established capabilities to match financial services companies in terms of brand value of trust and the quality of customer experience. In addition, the investment capacity and technology architecture of these 'BigTechs' enable them to drive and monetise on insight with speed and scale.

To address the dual challenge of competitive threat and supply chain vulnerability, incumbent firms need, as a first step, to close the gap between their digital aspirations and the reality of their legacy IT estates. There are some no-regret moves that could be undertaken: reducing reliance on legacy systems; decluttering and decommissioning redundant systems; and using analytics to provide modelling on key operational risks. But to fully harness the power of digital finance, incumbents may need to rebuild the technology architecture and redesign their operating models. Launching an entirely new digital entity alongside the legacy organisation may be necessary, so might be the integration of global scalability in operating models to harness the benefits of implementing key technologies such as the Cloud on a supranational basis.

Ultimately, financial activities may start to look very different. To effectively engage with the fintech ecosystem, particularly after the Second Payment Services Directive (PSD2) and Open Banking, incumbent firms may need to decouple financial products from their distribution channels and make a conscious pivot towards platform strategies to capitalise on their 'digital assets', including customer data, proprietary algorithms or business processes. This means that on top of financial intermediation, firms may need to define rules of how they engage with fintech players in the ecosystem and explore strategies to monetise proprietary IP and data.

The soundness of the risk department will be key in safeguarding this transformation. Financial firms need to enhance governance structure and risk management processes from strategic planning to change management, to ensure that they adopt new technologies safely within their operating models and adapt risk frameworks to take account of new risks and threat vectors arising from cyber and technology risk, as well as data privacy and protection considerations amplified by PSD2 and the General Data Protection Regulation (GDPR).

Technology is set to become the dominant operational risk

A direct consequence of the digitisation of financial services is that operational processes across the value chain will become predominantly supported on technology platforms. The operational risk profile of the firm will therefore increasingly correlate to the risks associated with this technology. If the technology does not function as expected, or if it becomes temporarily unavailable for any reason, due to cyber-attacks, systems failures or third-party business continuity risks, this can give rise to significant operational risks, impacting on customer service, and in some cases, the stability of wider financial markets.

In particular, boards need to demonstrate their awareness of any external service components or industry utilities that are embedded within their business. They also need to ensure that the resilience of operational processes and key controls has not been compromised as part of any digital transformation. The use of third-party and fourth-party partners has enabled financial firms to respond to the evolving industry landscape and changing consumer demand in an agile manner. The implementation of PSD2 and Open Banking will accelerate this trend further still. But as financial firms' supply chains and ecosystems grow,

[5] Accenture, FinTech's Golden Age, July 2016.

90%

of the data in the world today has been created in the last two years

Source: IBM

so will their definable risk landscape. The resilience of operational processes and the soundness of control frameworks are fundamental for any digital transformation. Firms must be vigilant to ensure that fintech 'component solutions' are being appropriately integrated into the supply chain, for example, ensuring that the fintech firm has effective recovery options, is not overly limited in its financial resources and does not have development centres in remote or unregulated locations.

The current regulatory response to this is that supplier risk, for example, is addressed by existing supply chain or outsourcing risk regulation and that it is a management responsibility to monitor the business and technical performance of the firm in question. In practice, however, the nature of many suppliers' own business models makes it difficult to control for risk using these general regulatory principles. Some regulators have begun to adapt, for example, by producing specific guidance on outsourcing to cloud service providers. However, in general, most jurisdictions remain wedded to existing views of the risks generated by financial technology. In the case of cloud computing, for instance, it is worth asking whether the technology can reasonably be understood as outsourcing at all or whether it is something else altogether, for example, a developing utility like electricity. As the technology risk landscape evolves firms are adapting their controls and processes to ensure risk is sufficiently accounted for. However, as firms adapt so too must the regulatory principles under which they operate.

At the heart of this evolving operational risk landscape lies the risk taxonomies which must recognise these implications, but also retain the agility to support emerging business and technology solutions that are sourced either internally or externally. There will be a substantial benefit to the industry in developing these new taxonomies collaboratively and in conjunction both with the technology suppliers and regulatory community. This process should consider both how to achieve a consistent treatment internationally and also how capital charges could be evolved to place greater emphasis on the effective management of technology and cyber risks. As a consequence, financial services firms are working hard to develop a wider understanding of these new risks, so they can support the development of effective and forward-looking industry oversight. This report highlights three key technological developments that will have the greatest impact in shaping the financial services landscape. These are:

1. Artificial Intelligence and Machine Learning
2. Cloud Computing
3. Distributed Ledger Technology

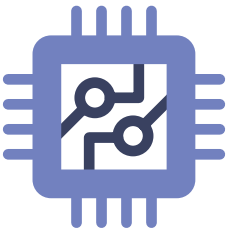
The three technological innovations we have outlined in this report have several commonalities. They are global in nature, their impact will be felt cross-border and therefore would benefit from common global standards. They are so fundamental in their impact that they present not just micro financial, but also macro financial or systemic risks. They are all powered by big data and data analytics, and therefore share common operational risks in terms of new protocols for managing data securely and protecting against cyber-attacks. Undoubtedly each of these innovations will create massive benefits for financial firms and their clients, as well as improving the operation of the wider financial market. But in realising those benefits, senior managers and regulators need to remain ever vigilant in their efforts to protect clients, markets and shareholder in this new and emerging risk landscape.

Part 1 – Artificial Intelligence and Machine Learning

The practical applications of AI and machine learning to financial services

Artificial Intelligence, the use of machine learning algorithms to identify and predict patterns, has been implemented in many facets of the financial system. Machine learning algorithms vary according to the level of human intervention required in labelling the data. These can be classified into the following categories:[6]

Category	Characteristics
Supervised learning	The algorithm is fed data that contains labels on some data points, which allows the algorithm to 'learn' a general rule of classification that it will use to predict the labels for the remaining observations in the data set. For example, this might help it to quickly identify fraudulent information.
Unsupervised learning	The algorithm is fed data that does not contain labels. Instead it must detect patterns in the data by identifying clusters of observations that depend on similar underlying characteristics. For example, securities that have characteristics like an illiquid security, that is hard to price. If the algorithm can find an appropriate cluster for the illiquid security, pricing of other securities in the cluster can be used to help price the illiquid security.
Reinforcement learning	This falls between supervised and unsupervised learning. The algorithm is fed an unlabelled set of data, chooses an action for each data point, and receives feedback (perhaps from a human) that helps the algorithm learn. For instance, reinforcement learning can be used in robotics, game theory, and self-driving cars.
Deep learning	Inspired by the structure and function of the brain, deep learning algorithms, (likened to artificial neural networks), can be used for supervised, unsupervised or reinforcement learning. Deep learning has led to remarkable results in image recognition and Natural Language Processing (NLP).



40x

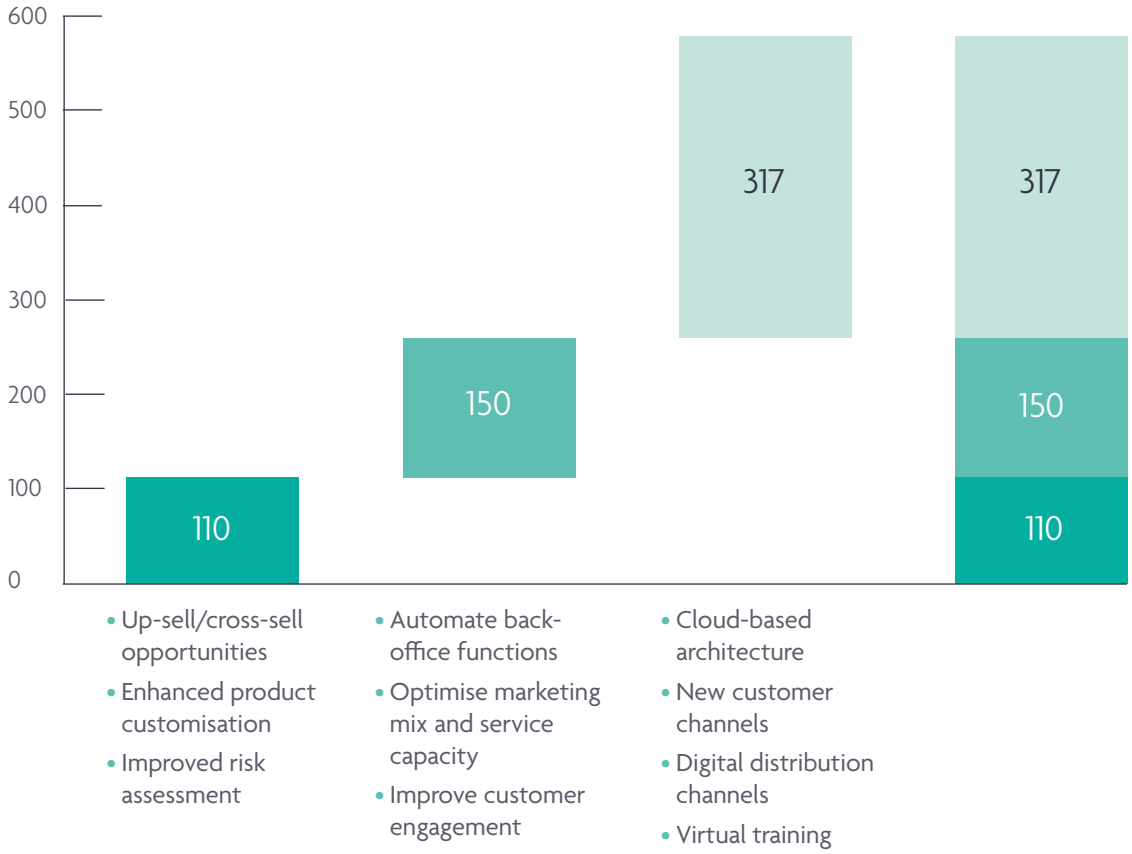
Increase in processing power between the fastest supercomputer of 2010 and the fastest today.

Source: McKinsey

[6] Artificial intelligence and machine learning in financial services, Market developments and financial stability implications, Financial Stability Board, 1 November 2017.

The potential benefits of AI and data analytics solutions are expected to be substantial and such benefits will be present across much of the value chain.

Figure 1: A data-driven transformation could lock nearly $600 billion in economic impact in retail banking (US$ bn)



Source: McKinsey, The age of analytics: competing in a data-driven world, December 2016.

It takes artificial intelligence 1/4 second to reconcile a failed trade vs. 5–10 minutes by a human

Source: BNY Mellon, 2017

To date, financial services companies have been lagging other sectors in the use of AI and data analytics, but are becoming increasingly active in seeking to exploit this exciting new technology. Predictive analytics are helping to shift the business management lens from historic to forward-looking.[7] American Express, for example, now uses analytics to predict loyalty and believe they are able to identify a quarter of the accounts that will close over the next four months. Cambridge-based behavioural analytics firm FeatureSpace, who initially developed their platform to identify online gambling fraud, has demonstrated improvements in the region of 70 per cent for bank transaction approval or denial accuracy, through examining customer behaviour patterns and adapting the level of user validation required in real time.

Further examples of AI include credit scoring tools that use machine learning to speed up lending decisions, while potentially reducing credit risk. Lenders are turning to additional, unstructured and semi-structured data sources, including social media activity, mobile phone use, and text message activity, to capture a more nuanced view of creditworthiness, and improve the rating accuracy of loans. In addition, client-

[7] Gartner, Organizations Will Need to Tackle Three Challenges to Curb Unstructured Data Glut and Neglect, June 2015.

facing chatbots, or 'virtual assistants', are already helping customers transact or solve problems. These automated programmes use NLP to interact with clients in natural language (by text or voice) and use machine learning algorithms to improve over time. Chatbots are typically used as part of financial services firms' mobile apps or messaging applications. While many are still in the trial phase, there is potential for growth as chatbots gain increasing usage, especially among the younger generations, and become more sophisticated. The benefits also extend to improving the effectiveness of KYC, regulatory reporting, anti-money laundering and fraud detection, complaints handling and cyber resilience. AI is also likely to have a profound impact on how firms model risk within their business. Some applications are already live. For instance, one global corporate and investment bank is using unsupervised learning algorithms in model validation. Its equity derivatives business has used this type of machine learning to detect anomalous projections generated by its stress testing models. Each night these models produce over three million computations to inform regulatory, internal capital allocations and limit monitoring.

Emerging risks for financial services firms and financial regulation associated with AI and machine learning

Many developments could impact future adoption of a broad range of financial applications of AI and machine learning. These developments include continued growth in the number of data sources and the timeliness of access to data; growth in data repositories, data granularity, variety of data types; and efforts to enhance data quality. Continued improvement in hardware, as well as AI and machine learning software as a service, including open-source libraries, will also impact-on continued innovation. Development in hardware includes processing chips and quantum computing that enable faster and more powerful AI. These developments could allow cheaper and broader access to AI and machine learning tools that are increasingly powerful. They could make more sophisticated real-time insights possible on larger data sets, such as real-time databases of online user behaviour or internet-of-things (IoT) sensors located around the world. All of these developments warrant further attention from financial services companies, in order to identify, measure and mitigate new risks associated with the technology. The nature of any conduct and financial stability implications depends critically on the uses of AI and machine learning, for example, given the potential for market herding with very large trading volumes and at very high speeds. To assess these implications, questions to be considered would need to include which AI and machine learning tools are being used to make which types of decisions, on what time scales, to address which financial functions, and where and at what level human involvement is being integrated. In its latest report, the Financial Stability Board (FSB) highlighted three areas where AI poses emerging threats to financial stability.

Emerging risks	Concerns
Loss of market transparency	The use of AI and machine learning risks the creation of 'black boxes' in decision-making. In particular, it may be difficult for human users at financial institutions – and for regulators – to grasp how decisions, such as those for trading and investment, have been formulated. Moreover, the communication mechanism used by such tools may be incomprehensible to humans, thus posing monitoring challenges for the human operators of such solutions. Financial institutions applying AI and machine learning to their businesses need to establish well-designed governance and maintain auditability. This is a particular concern because, as many AI and machine learning models are being trained during a period of low market volatility, a widespread use of opaque models may result in unintended consequences.
Market concentration risks	AI and machine learning may affect the type and degree of concentration in financial markets in certain circumstances. For instance, the emergence of a relatively small number of advanced third-party providers in AI and machine learning could increase concentration of some functions in the financial system. Network effects and scalability of new technologies means that AI solutions are increasingly being offered by a few large technology firms. As the FSB reports "this could in turn lead to the emergence of new systemically important players that could fall outside the regulatory perimeter".[8] This could result in increased third-party dependencies and trigger systemic risks if a large technology provider were to face a major disruption or insolvency. Similarly, access to big data could be a source of systemic importance, especially if firms are able to leverage their proprietary sources of big data to obtain substantial economies of scope.
New forms of risk transmission in financial markets	Applications of AI and machine learning could result in new and unexpected forms of interconnectedness between financial markets and institutions. For instance, the increased use of previously unrelated data sources in designing trading and hedging strategies.

In conclusion, the successful adoption of AI will require a new mindset for both firms and regulators. Protecting and growing the financial market with AI requires strong and innovative assessment of AI and machine learning in view of their risks, including adherence to new protocols on data privacy, conduct risks, and cybersecurity. The validation of models that 'self-build' (for example genetic applications for credit scoring), predictive analytic models that are opaque (for example neural networks) and automated advisory models that could be prone to inadvertent mis-selling, would all benefit from best practice principles and guidelines to reduce ambiguity in this area. Adequate testing and 'training' of tools with unbiased data and feedback mechanisms will also be key, so will the build-up of skills in-house to understand and supervise AI and machine learning models.

[8] Financial Stability Board, Artificial intelligence and machine learning in financial services, November 2017, page 1.

Part 2 – Migrating a Regulated Industry into the Cloud

The practical applications of cloud computing to financial services

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of remote servers provided by third parties, which can be accessed anytime and anywhere. This includes access to networks, servers, storage, applications and services that can be rapidly scaled up or down in line with demand. Three main models are outlined in the table below:

Type of cloud support	Characteristics
Software as a Service (SaaS)	This enables firms to access cloud-based software. The key benefit is that software is maintained and updated routinely (often daily) and can be accessed on demand.
Infrastructure as a Service (IaaS)	Builds on SaaS with firms not only using software but also the provision of base infrastructure services such as processing power or storage.
Platform as a Service (PaaS)	PaaS builds further on the models above, whereby the user receives a runtime environment with a functioning operating system, database or network service. Platforms can be built on software service, standalone, open source or part of an infrastructure service, all with the intention of helping programmers to build software faster and more efficiently.

Average number of clouds leveraged by users.

Source: RightScale

Financial institutions derive clear benefits by using one or more of the approaches above. At the most basic level, cloud computing is best understood as an enabling technology fundamental to successful digital transformation. Many of the most exciting technologies available to financial services firms (whether analytics and AI as mentioned above or blockchain and other distributed ledgers as discussed below) are based on cloud deployments of varying configurations. Many of the products in these areas are being developed not in house, but by specialist third-party businesses that are 'cloud native', meaning their whole business is run using the Cloud. Small fintech start-ups are especially likely to be 'cloud native' as cloud computing provides a way to access the high-quality computing resources their businesses require without committing to large fixed costs that most start-ups simply cannot afford. The ability of larger financial services businesses to better harness cloud computing will thus be beneficial to the fintech ecosystem, by enabling the financial sector's integration with start-ups and large technology providers alike.

Beyond enabling specific technologies cloud has several substantial benefits, including the ability to scale technology on demand, faster deployment cycles and the mitigation of some technology risks. A further corollary of the switch to on-demand compute resource is the shift from a fixed to a variable cost model, thereby freeing up resources to be invested in other more productive activities, like research and innovation. Finally, by allowing for the deployment and creation of a more harmonised IT estate in which legacy and new IT can co-exist, cloud is helping to foster the digital transformation of financial firms. Given these benefits, it is not surprising that financial services firms are increasingly focused on making greater use of cloud computing.

Compute and storage is shifting massively to cloud-service providers

As with analytics there has been a lag in the adoption of cloud technology among financial services companies compared to other industries. However, whilst many firms are still to establish their cloud deployment strategy, a growing number of progressive cloud deployments are now taking place within the UK. Virgin Money plans to launch its new digital bank in a cloud environment,[9] OakNorth is also an entirely cloud-based bank and further cloud migration programmes are currently underway within some of the largest UK banks.[10]

Emerging risks for financial services firms and financial regulation associated with cloud migration

One of the primary reasons for the slow adoption of cloud computing has been the associated operational risks for financial firms and the implications of financial regulation. Setting aside specific regulatory requirements, there exists an inherent tension between the product offered by cloud services providers (CSPs) and the regulatory needs of financial services firms. CSPs have historically offered a product in a standardised way, such that it can be used by any business and therefore produced and sold at scale. Entering the financial services market, with its extensive regulations, meant encountering customers who required individual approaches to the way in which products were designed, distributed and maintained, in order to meet what they perceived as their regulatory requirements. This clash in objectives was difficult for both sides. Banks found themselves put off by suppliers who insisted that their normal contractual terms were all that was available. They were also unaccustomed to contracting with suppliers with such significant market power in comparison to themselves and who could flatly refuse to accommodate their requests. On the other hand, the CSPs were frustrated as they went from bank to bank being told by each firm that different solutions would be required in order to meet the same regulatory obligations that held across the market. Although they could accept that they may need to tailor their product for financial services generally, to do so for each individual customer would run counter to their business model of offering standard on-demand computing power.

As is often the case, the truth lies somewhere in the middle. Although the CSPs have come some way in adapting their products for a heavily regulated industry, they still too often expect approaches to compliance to be standardised across the industry. In reality, compliance is dictated by the unique risk profile of each firm. A good example of this is the contrast between a bank like OakNorth, which began hosting their core system on Amazon Web Services (AWS) in 2016, and one of the globally systemically important banks (GSIBs). Because of the latter's systemic importance to the global financial system, the regulatory risk it is able to tolerate is lower than, for instance, a bank focused on a single section of the market within a single jurisdiction.

The solution to this impasse would seem to be the creation of industry standards or best practices which the CSPs could fit their products to and which financial services firms could rely upon to give them some assurance that their approach was compliant with regulatory expectations. Financial services firms recognised this early and, as a result, industry trade associations like UK Finance have been calling for such an approach for several years.[11] The CSPs also see the advantage of such an approach and are increasingly reaching out to work directly with financial trade associations and other industry groups, in an effort to reach across the sector. A positive development for the future of cloud computing in financial services is the call within the European Commission's recently released draft of their FinTech Action Plan for the creation of an industry group tasked with, among other things, developing standard contractual clauses for cloud computing in financial services. This is a progressive initiative from the EU which recognises what financial services firms and CSPs have been calling for.

20-40
Basis Points

Improvement in profitability following migration to the Cloud

Source: StrategyE, 2016

[9] Business Insider, Virgin Money starting its own digital challenger bank, 27 February 2018.

[10] Financial Times, OakNorth takes UK banking into the cloud, 26 May 2016.

[11] BBA FCA response and UK Finance EBA response.

Overcoming the Seven Hurdles to Cloud Adoption

In December of 2016 the British Bankers Association published a report, 'Banking on Cloud' identifying what were then seven key hurdles to the use of cloud in financial services.[12] Although the EBA recommendations do address some of these hurdles, they do not solve them, and in many ways, the list remains as relevant now as it was a year ago. The identified hurdles were:

1. Assessing the criticality of functions being migrated
2. The nature of effective supervision
3. The practical constraints in enabling regulators to have effective oversight of public cloud deployments
4. Managing the changes to internal risk frameworks to allow for differing risks
5. Data management
6. Data location and transferring data outside the EEA
7. The provision of adequate exit plans for a cloud contract

Just as there has been progress on the general approach to dealing with regulation as it applies to the use of cloud computing in financial services, so too there has been some progress regarding hurdles caused, at least in some part, by specific regulatory requirements. At the end of 2017 the European Banking Authority (EBA) released its recommendations for cloud outsourcing in financial services.[13] Although there was some disappointment across the industry and with CSPs that the recommendations did not go further toward alleviating some of the identified hurdles, they are, nonetheless, a welcome source of further clarity as to regulatory expectations – as well as being an important attempt to ensure harmonisation of regulatory approach on the part of national competent authorities.

Since the publication of that report a new concern has taken centre stage in regulatory thinking about cloud computing in financial services, that of concentration risk. The relatively small number of CSPs, with the vast majority of the market being serviced by AWS, Microsoft and Google, means that there is a possibility that any one of these firms could become systemically important to the global financial system. This concern was highlighted most prominently in a report written by the FSB in June of 2017, which identified concentration risk in technology outsourcing as one of the major threats to the systemic resilience of the financial sector.[14]

Concentration risk takes two forms. First, if a large number of financial services firms unknowingly use the same provider and that provider experiences an outage or business problems, the sheer scale of activities across the industry that could be affected could shake the stability of the system. Second, if a single systemically important financial firm hosts too many activities in a single provider, it may become incapable of functioning if that provider experiences an outage or business problems. Although individual firms can and should control for the second of these risks, they cannot know what services their competitors are using and thus cannot control for the first.

Regulators are now asking for as much information as possible in order to monitor concentration risk, requiring the reporting of any and all instances of cloud outsourcing. This creates difficulties as multiple regulators could request the same information in different formats at different times and have different reactions to that information. The EBA's recommendations are an attempt to harmonise regulatory approaches across the EU, but the danger remains that variation in regulatory

[12] Cite Banking on the cloud report.

[13] Cite EBA Final Recommendations Dec 2017.

[14] Financial Stability Board, Financial stability implications from FinTech, June 2017.

practice, not just in the EU but across the globe, will prevent the wider adoption of cloud computing in financial services and consequently prevent the benefits which cloud could bring, including to the wider fintech ecosystem.

The dominance of the market by a few large firms thus raises important public policy questions. Cloud computing rewards scale and to some extent the size of these providers increases their ability to withstand outages or disruptions. However, if a deeper market does not develop that allows true choice for regulated firms and other consumers, policymakers may be forced to treat cloud computing as a utility, much like the electricity distribution market, forming part of the critical national infrastructure. To counter this, CSPs should work to increase the inter-operability of their services so that regulated firms could more easily exit or relocate applications hosted in the cloud thereby reducing the potential damage to the financial system that could be caused by the failure of any one CSP.

Case Study: Microsoft Project Natick – the 'Cloud in the Ocean'

Microsoft's 'Cloud in the Ocean' project highlights the gaps between regulatory requirements and the potential of the technology.

Cloud vendors already provide data centres in many regional and global geographic areas. However, these data centres bring with them the energy-intensive challenge of cooling the large number of servers which provide the computing power being sold. An alternative physical environment that helps to address this challenge could be found at the bottom of the sea floor. In early 2016, Microsoft submerged a 38,000lb steel tube that contained the processing power of 300 PCs off the coast of California to test the concept.[15] The company claims this was the first time a data centre has been operated in the sea, and that it worked. Other advantages are the speed to deploy, as site construction and planning schedules can be significantly reduced, whilst still operating relatively close to the centres of urban population that make the greatest use of them.

However, financial regulators often require physical access to data centres as part of their supervisory function. This has created a major hurdle for financial services firms and CSPs in their contractual negotiations as the former attempt to include provisions for physical access for regulators. This is something rejected by the CSPs, who would be faced with an unsustainable level of frequent regulatory inspections given the sheer number of clients they support.

This point was one of the many frictions which slowed the adoption of cloud computing in the sector. Thankfully, regulators including both the FCA and EBA increasingly acknowledge that physical access to data centres may not always be necessary (although it is still required). However, the case remains an example of how difficult it is to apply existing regulation, which was written to address traditional outsourcing, to the new world of technology which is operating at a significantly greater scale and across multiple jurisdictions.

In conclusion, there are many benefits of building applications in the cloud, including faster time to market, lower development costs, expanded testing, enhanced controls, automatic scaling and failover and quicker provisioning. However, these benefits, as well as the corresponding potential ubiquity of cloud computing across financial services, have contributed to the greater focus on operational and IT risk on the part of regulators and firms. Many of the questions raised by this relatively new technology, both for regulators and policymakers, are yet to be addressed. We recommend that policymakers in jurisdictions across Europe and around the world emulate the approach of the European Commission and make the adoption of cloud computing across sectors, including financial services, a priority for their economies.

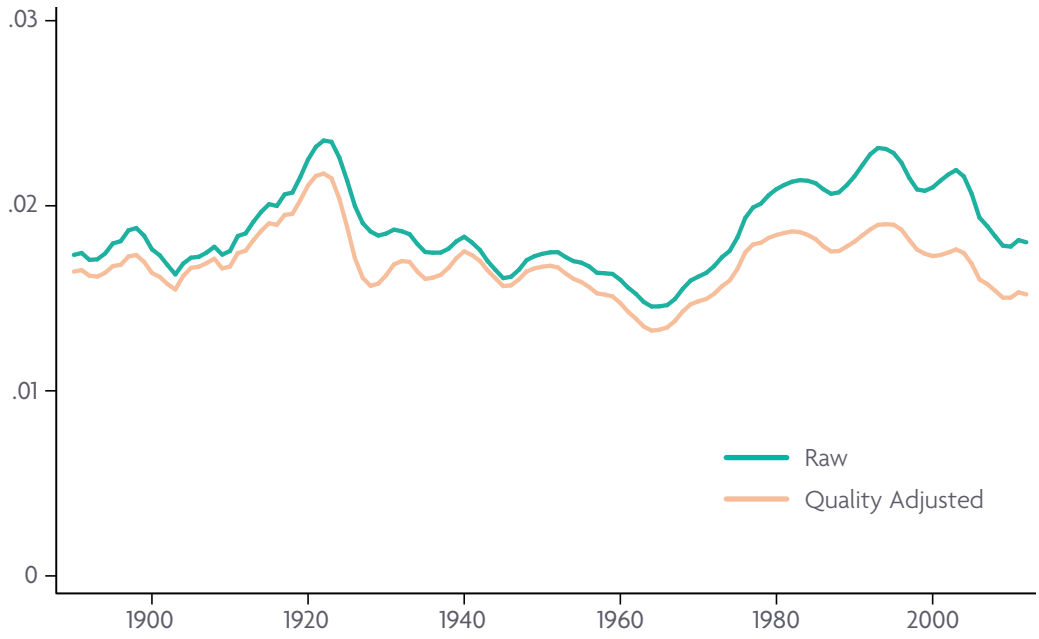
[15] The Atlantic, Moving the Cloud to the Bottom of the Ocean, 2 February 2016.

Part 3 – Distributed Ledger Technology

Distributed Ledger Technologies (DLT) are a form of database, in which changes to the ledger are agreed by an automated consensus mechanism rather than a central database administrator. In this way, they can operate across multiple organisations without the need for complex sets of reconciliation processes or intermediaries. The records posted on the distributed ledger through the consensus mechanism are also typically immutable, which reinforces the trust between counterparties, and can offer full transparency where appropriate to regulators and supervisors.

Andy Haldane, Chief Economist at the Bank of England, has referred to the remarkable fact that the cost of financial intermediation in the US has remained largely unchanged over the course of a century, averaging around 2 per cent of the total value of intermediated assets.[16] After a century of stasis, the idea of financial intermediaries sharing a common ledger could now be a game changer for the industry, with the potential to lower costs, reduce collateral and capital requirements, reduce the need for intermediation and streamline key elements of the banking operating model. The prospect of delivering wholesale operational improvements whilst supporting greater regulatory transparency means that DLT could be an essential ingredient in the development of a sustainable, digital financial services industry.

Figure 2: Unit Cost of Financial Intermediation



[16] Philippon (2014), "Has the U.S. Finance Industry Become Less Efficient? On the Theory and Measurement of Financial Intermediation.

10%

of global GDP likely to be stored on blockchain platforms by 2027

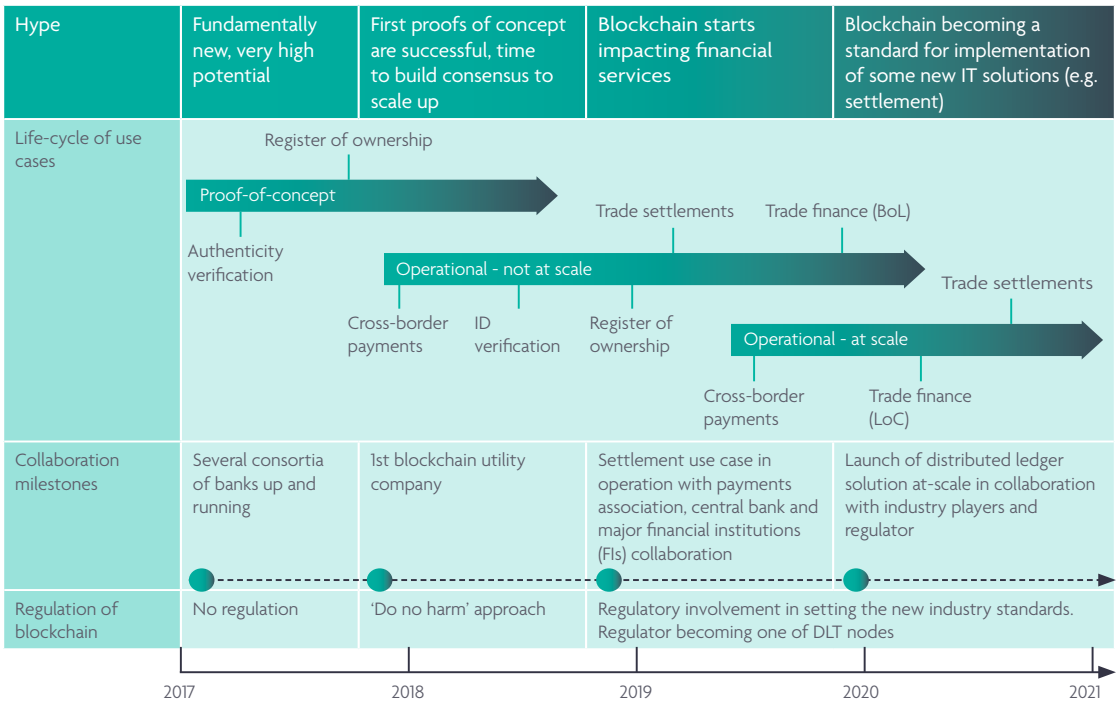
Source: World Economic Forum

Financial services firms are aware of this potential. Some estimates of direct spending by the leading financial institutions on DLT prototypes in 2017 exceed $1bn and similar funding levels to incubate other solutions are reported from the venture capital community.[17] In the capital market spending is expected to grow rapidly, to an estimated $400m in 2019 from a base of $30m in 2014.[18] Some examples of the financial markets use cases considered most likely for early adoption include :

- Trade finance and syndicated lending (an order of magnitude reduction in administrative time and effort);
- Clearing and settlement of securities and derivatives (potential annual savings of $11-12 billion);[19]
- Payments (estimated saving could be up to one third of current payment operating costs);
- 'Know your customer' (estimated to have the potential to save the industry around $3-5 billion annually).[20]

Major financial institutions typically have numerous blockchain projects underway – portfolios of over 20 initiatives are not uncommon – with the majority being expected to use a private, or permissioned, rather than a public distributed ledger solution for the greater privacy and security that this affords. Increasingly active are the market infrastructure firms whose core business could be most directly impacted, as they seek to set the agenda for future DLT developments rather than have it set for them. Two examples of this are DTCC and Swift, the former of which is working with IBM, Axoni and R3 to enhance their Trade Information Warehouse with a DLT solution for the processing of derivatives post-trade lifecycle events and the latter, which has launched a DLT proof of concept, using Hyperledger, that supports real-time reconciliation of nostro accounts.[21] The chart below sets out in more detail how the life-cycle of financial services use cases has developed towards fully scalable applications being adopted alongside existing market infrastructure.

Figure 3: The future of blockchain



Source: Blockchain info, expert interviews

17 Magister Advisors, Blockchain & Bitcoin 2016: A survey of Global Leaders, 2016.

18 Financial Times, Blockchain for banks still at the 'gluten' stage, 9 December 2015.

19 Goldman Sachs, Profiles in Innovation: Blockchain, May 2016.

20 Goldman Sachs, Profiles in Innovation: Blockchain, May 2016.

21 DTCC press release, DTCC Selects IBM, AXONI and R3 to Develop DTCC's Distributed Ledger Solution for Derivatives Processing, 9 January 2017.

Emerging risks for financial services firms and financial regulation associated with DLT adoption

With the scale of experimentation and potential adoption, maintaining operational resilience will require a significant level of industry scrutiny. Concerns raised by DLT include privacy, security, scalability and competition. Taking the example of privacy, even if the keys or certificates to each transaction are anonymised, in a small network of users it can be easy to identify participants by analysing the transaction flow. Financial services firms are understandably concerned about the idea of sharing a network that allows their competitors to see even anonymised records of their transactions.

Technological solutions are possible. The company Credits has developed the concept of 'cross-chains', which address privacy concerns by allowing each participant to maintain a separate bilateral chain with all other participants. To increase security and address privacy others have suggested the potential of storing data 'off-chain', thereby reducing the risk of information loss. However, these solutions, although they address some problems, also reduce the benefit of using DLT, in the case of cross-chains by slowing the clearing of transactions or in the case of side chains, reducing the ability to test and confirm the veracity of information on the ledger.

With the rapid adoption by banks and payment companies of new systems like RippleNet, providing an alternative settlement infrastructure technology, resilience has become a major issue for central banks and regulators. The Bank of England (BoE) highlighted their concerns in Mark Carney's speech to the Mansion House in June 2016[22] and these concerns were reiterated in the FSB report from June 2017. To address such concerns the BoE is actively exploring blockchain technology within their FinTech accelerator programme, with the intent of deepening their understanding of its scalability, security, privacy, impact on financial crime, interoperability and sustainability implications. Many similar initiatives are underway in other jurisdictions.

Case Study: RippleNet – DLT drives the development of new market infrastructure

RippleNet is a network on which real-time clearing and settlement of financial transactions can occur between banks and payment providers. Its Interledger Protocol (ILP) allows for scalable transaction processing, transaction privacy and interoperability between independent networks and the sending and receiving of international payments, notable for financial services firms operating across borders. Ripple uses a consensus system instead of a proof-of-work system, eschewing miners and anonymous nodes in the validation of transactions. This is part of an attempt to create an environment of closed-door policies that banks can operate within whilst also transitioning to the transparent realm of blockchain.[23] In terms of its applicability to the wider banking system, in March 2017 the Bank of England engaged in a proof of concept with Ripple to study how DLT could be used to model the synchronized movement of two different currencies across two different ledgers.[24] Whilst the BoE concluded that DLT was still too nascent in its development to support its core real-time gross settlement system (RTGS) at the present, it indicated that a new iteration of its RTGS should be DLT-compatible in the private sector. Indeed, the place for DLT within financial market infrastructures (FMI) is predicted to be refined to post-trading activities (clearing, settlement, custody and asset servicing). As RippleNet continues to grow, the question of how well its technology adheres to the Principles for Financial Markets Infrastructure will be pertinent. This is another example of regulation written for a fundamentally different technological approach, which now needs to be applied, or adapted, to fit the new realm of technological possibilities.

[22] CityA.M., FinTech and blockchain top Mark Carney's Mansion House agenda, 16 June 2016.

[23] Don Tapscott and Alex Tapscott, 2016. Blockchain Revolution: How the technology behind bitcoin is changing money, business and the world, p68-69.

[24] Bank of England, Fintech Accelerator – results of latest round of Proofs of Concept, 10 July 2017.

30%

Potential reduction to bank infrastructure costs by blockchain adoption

Source: Accenture, 2017

The DLT environment has been marked out by several collaborative initiatives, with the potential to help address operational risk and other concerns raised by the use of DLT. There are a number of forums now established to develop and promote standards for industry-wide DLT adoption. One example is Utility Settlement Coin, an asset-back digital cash instrument using DLT within global institutional financial markets. The network so far includes Barclays, HSBC, State Street, Credit Suisse, UBS and others. Another well-known collaborative effort is R3 CEV, whose initial members joined in late 2015 and now has over 100 major financial institutions among its members.[25] R3 CEV is seeking to develop a suite of standards for DLT deployment across a number of specific use cases, including smart contracts, which can potentially be used to automate complex legal documents such as trade finance deals, syndicated loans, master service agreements or credit facilities for securities transactions. Productivity gains are potentially dramatic in these domains, for example, the time needed for loan syndication could drop from 20 days to just a single day.[26]

The International Organization for Standardisation (ISO) is raising the profile of blockchain standards setting through the establishment in September 2016 of an international technical committee. The financial regulatory community has also been highly engaged. The European Commission Directorate General for Communications Networks, Content and Technology (DG CNCT) is also now actively working with industry and regulatory bodies across the EU to promote interoperability standards for DLT. The European Securities and Markets Authority (ESMA), which ran a public consultation during 2016 to examine the regulatory implications of distributed ledgers on existing market infrastructure, has not identified any major impediments in the EU regulatory framework which would prevent DLT adoption. However, it believes that areas such as the legal certainty attached to DLT records and settlement finality (i.e. being able to identify the point at which ownership legally changes hands) may require further clarification. There is no harmonised definition of these functions across the EU at present, with the task being performed by a wide range of depositories, custodians, registrars or notaries and so may well prove to be one of the more complex hurdles to overcome.

In conclusion, as with the other technologies covered in this report, consistency of approach from regulators is welcomed by the industry. As innovative technology providers play an increasingly important role in providing and maintaining FMI, regulators need to ensure that market critical operations and services are maintained against a whole host of risks including systemic, legal, liquidity and credit risks, insolvency and general business operational risks. There appears to be a growing consensus that the definition of best practice should be led by the industry, but supported by the regulator in line with their guiding principles. If this intent is followed through in practice by regulators and industry groups, then an environment is well placed to emerge that can liberate the innovative and exciting potential of distributed ledgers.

[25] Fortune, Why Goldman Sachs and Santander Are Bailing on R3's Blockchain Group, 21 November 2016.

[26] Bloomberg, Blockchain for Banks Probably Can't Hurt, 1 September 2015.

Conclusion

Digital technology is rewriting the business fundamentals of financial services. This report focuses on three major technology innovations which are each driving significant changes across the financial services sector on a global basis. Artificial intelligence and machine learning allow for the development of new risk management tools alongside new, more efficient ways of delivering client services. Cloud computing reduces the need to build and maintain proprietary IT estates, making firms more nimble and cost-effective, in doing so removing a major barrier to new market entrants. DLT allows for the verification of data within a decentralised market infrastructure. Underpinning each of these innovations is the growth of Big Data and data analytics, which act as a catalyst for enabling many of the efficiencies and new economies of scale referred to in this report.

Taken together, these changes herald the creation of a new value chain in which data, software, platforms and infrastructure are driven by new digitised processes. New business activities, processes and models which make use of digital technologies – accompanied by the new skills and business culture necessary to ensure successful adoption – will prove key in developing sustainable business propositions. It is those firms which commit to undertaking full-scale transformation that will be best placed to deliver the greatest benefits to clients and shareholders.

Being able to embrace these benefits means also fully understanding, and addressing, the emergence of new non-financial risks. The use of machine learning and algorithms delivers greater volumes of market activity at ever greater speeds. That presents its own challenges for those who are responsible for supervising financial markets and promptly identifying the agglomeration of new risks. Technology and data companies are taking an increasingly significant role in developing, innovating and managing not just internal processes within their client firms, but also the underlying market infrastructure on which those clients transact business. Cloud computing and DLT present new and uncharted frontiers in the development of financial market infrastructure. Cloud computing in particular, with its reliance on a small number of large Cloud Service Providers, also presents a new frontier in market concentration risk, to which large parts of the financial sector are increasingly exposed.

The responsibility for managing these third-party risks clearly rests with regulated financial institutions. That means senior managers putting processes in place to understand the operational risks across their business supply chain and adopting adequate contingency planning. But the reality is that firms cannot protect themselves from wider market risks. The way in which risks are transmitted across markets is rapidly changing. There is a clear and growing role for regulators, cooperating on a cross-border basis, and working closely in tandem with financial institutions, in particular the GSIBs, to effectively monitor and mitigate emerging risks. The FSB has already signalled key areas of financial stability risk arising from technology use in its June 2017 report. Key among the FSB's concerns were the growing need to manage operational risks from third-party service providers; the need to mitigate cyber risks and the need to monitor the potential macro-financial systemic risks arising from fintech activities. As the FSB highlights, it is only through all stakeholders – firms, policymakers and regulators – working together, sharing data and intelligence, developing guidelines, can we hope to deliver the benefits of digital transformation in a truly sustainable manner.

About the Authors

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