



Government
Office for Science



FinTech Futures

The UK as a World Leader in Financial Technologies

A report by the UK Government Chief Scientific Adviser



UK FinTech generated **£20bn** in revenue in 2014

FinTech could play a role in reaching the **2.5 billion** unbanked around the world

The UK has 2.4 million people working in high-tech industries, 825,000 of which are STEM roles



Banking and securities institutions spent **£319bn** on IT in 2014

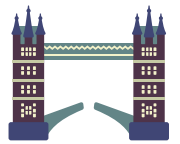
The FCA estimates smartphone penetration as high as **95%** in the future



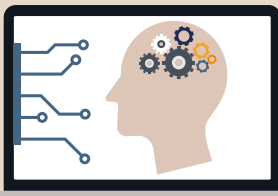
58% of adults had internet access via a mobile phone in 2014

UK-wide, 135,000 work in financial services technology

25% of global FinTech FDI projects in the last five years were in Europe, nearly half of which were in London



The technologies that could be involved in FinTech include:



Machine learning and cognitive computing



Big data analytics



Digital currencies and blockchain



Mobile payments

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Foreword

UK science and the financial sector are among the country's most valuable assets. Both are key priorities to enable the Government to support the economic recovery and national prosperity. Science and the financial sector are interdependent. The financial sector, which is evolving extremely rapidly, depends for its research and development on the science base, which encompasses science, engineering, technology and social sciences. Science in turn can feed from the enormous range of challenges that will arise, e.g. from mathematical and quantum approaches to cryptography to social scientific questions about identity, privacy and the implications of machine learning for individuals and society.

The way in which the Government, business and academia respond to the development and commercialisation of new financial business models and disruptive innovation, known collectively as 'FinTech', will be of particular importance in positioning the UK financial sector for the future. The Government is committed to cementing the UK's world-leading position in FinTech and has already taken significant steps towards achieving this goal.

As part of this work, the Chancellor of the Exchequer, the Rt Hon George Osborne, commissioned me to provide a report on FinTech futures and to make recommendations that will ensure that the sciences continue to contribute most effectively to FinTech. This report builds on the current work of HM Treasury and other parts of the Government to provide a longer-term vision for the UK FinTech sector. Its recommendations are intended to provide a firm foundation to support and catalyse the growth of the sector out to 2025. In particular, it makes the case that the Government, regulators, business and academia must work together closely and in innovative ways.

Like any technology, FinTech is neither good nor bad in itself. It is the specific uses of the technology that can be good or bad. It is already clear that FinTech will disrupt existing business models. It creates huge opportunities for development and delivery of better business and consumer services and to promote financial inclusion for people who are currently excluded. But this cannot be taken for granted. There is plenty of potential for FinTech to offer new methods for fraud and exploitation of businesses and consumers and, if poorly implemented, could increase financial exclusion. That is why it is important that the Government and regulators maintain a close watch on the sector as it emerges.

I am indebted to the expert panel who have advised me and contributed to the drafting of the evidence papers that provide the background and support for my recommendations to HM Treasury and the Government as a whole.

Sir Mark Walport
Government Chief Scientific Adviser
March 2015

Executive Summary

Introduction

Financial technologies (FinTech) integrate finance and technology in ways that will disrupt traditional financial models and businesses and provide an array of new services to businesses and consumers. The hybridisation of technology with the traditional processes of finance – working capital, supply chain, payments processing, deposit accounts, life assurance and so on – replaces traditional structures and ways of working with new technology-based processes.

The innovations emerging from the FinTech sector carry enormous transformative power for the financial sector. They also bring new risks that must, as far as possible, be anticipated, prevented and managed. The UK has a competitive edge with its world-class science and research base, its position as the world's leading global financial services centre, and a regulatory system that recognises and promotes innovation. With a market currently estimated to be worth £20bn in annual revenue and growing, the UK and Ireland is the fastest-growing region for FinTech investment globally.

The Government's stated ambition is for the UK to cement its world-leading position in developing FinTech, and to become a global hub for financial innovation. To succeed, it will be necessary to foster the best investment environment, the right tax system, the appropriate regulatory framework and the best infrastructure for FinTech companies to flourish within the UK.

However, this is still a young and developing sector and the UK will need to work hard to secure its place in the face of competition from the rest of the world. There are also emergent risks inherent in such an innovative and fast-moving sector. Concerns about data privacy, impacts on people and the workplace, inappropriate risk-taking by consumers and the impact of decentralised digital currencies on monetary policy are just some of the challenges that will need to be addressed by the Government, business and academia working in partnership.

The Chancellor commissioned the Government Chief Scientific Adviser to lead a review into the technologies, enablers and barriers that will shape the FinTech sector out to 2025. An expert advisory group, seminars and evidence from academia, industry and the Government have provided the evidence for this review.

This executive summary sets out the ten recommendations of our work. These are supported by six chapters with the following themes:

- Vision
- Technology
- Work, People and Policy
- Business Models
- Globalisation and UK FinTech
- RegTech: The Future of Financial Regulation

Vision

Attaining global leadership in FinTech requires a clear vision of what this means and what needs to be overcome to establish this position. We suggest the following:

“The UK will be the premier location for starting, growing and retaining innovative financial technology businesses. The UK environment will provide outstanding access to leading academic talent, investment and facilities and promote global thought leadership on emerging digital solutions. It will provide unrivalled international connectivity, a regulatory environment that balances risk and innovation, and will foster and maintain the optimal conditions for growing businesses.”

The role of Government is to provide leadership and catalysis – the business and academic sectors must play the major role in developing and delivering new business models. The regulators are key to ensuring that existing, new and emerging risks are identified and managed effectively.

Recommendation 1

A clear vision from Government, combined with a stable policy environment, will encourage the private sector to invest in FinTech. However, what is also needed is coordination across Government, regulators, business and academia and we therefore propose that:

Government establishes a ‘FinTech Advisory Group’ with representation from the Government, regulators, trade associations, academia and business.

The group will have a remit to:

- coordinate activity around the other recommendations in this review, starting with the creation of a fully costed proposal for a grand challenge programme (Recommendation 2);
- provide a neutral forum for dialogue between interested parties to help inform Government, regulatory and business policy, providing a conduit for issues and problems that the FinTech sector is facing and channel these into recommendations to Government;
- reach out to other established groups with an interest in FinTech both within Government and the private sector;
- provide a horizon scanning capability to monitor threats and risks and identify opportunities for strengthening the sector.

Responsibility for setting up this body will need to be agreed but to be successful it should be supported by an adequately funded secretariat.

Recommendation 2

Challenge competitions can be an effective way of catalysing the application of new technologies to new areas where the market alone may be insufficient as catalyst. This leads to our second recommendation:

The Government should create a programme of grand challenges on FinTech for academia, business and the third sector to answer.

This would enhance the exchange of ideas and knowledge and provide inspiration to the FinTech community by challenging creative start-ups and incumbents to find innovative solutions to global problems.

Those working in the area should play a major role in suggesting the topics for a grand challenge programme. Our initial suggestions include:

- Setting FinTech entrepreneurs the challenge of creating solutions that will have large effects on reducing financial exclusion.
- Creating a UK community that will use FinTech to deliver new tools that will enable regulators to operate more effectively. This could create a whole array of important 'RegTech' tools and businesses. See Recommendation 9.

Technology

Technology provides the potential to transform financial services. Using technology to provide effective financial advice could enable the creation of personalised approaches to providing financial services. This could, if done well, help rebuild consumer trust in the financial sector – but the corollary to this is an obvious threat.

We identify four key groupings of technology advancement that will enable the FinTech sector both in the near term and over the next decade:

1. Machine learning and cognitive computing
2. Digital currencies and blockchain
3. Big data analytics, optimisation and fusion
4. Distributed systems, mobile payments and peer-to-peer applications

Looking to the future, technology developments will drive further advances in computer power and speed, massive 'in-memory' computer capabilities, data clouds, and the ability to deliver technology 'as a service'. Cognitive systems will continue to drive 'human-like' interfaces, and enable more informed decision making and discovery of new insights from vast amounts of structured and unstructured data. The Semantic Web will enable the sharing of content beyond the boundaries of applications and websites. This will drive the rapid adoption of new industry capabilities and services. Equally these technology innovations will be applied to advance security, privacy and cyber capabilities. Further into the future, quantum computing could transform and disrupt existing computer systems.

The key message from this review is that, in financial services, the question is not what new technology will be invented to change the industry, rather how will Government, industry and regulators implement and use technology innovation in ways that will benefit consumers, businesses and the financial sector? The potential large social and economic gains from these technologies will depend not on the technologies *per se* but on how businesses and others apply these technologies for good or evil. A key role for Government and regulators is to promote the former and prevent the latter. And it is likely that new business models will disrupt the existing vertical silos that define the financial sector.

In this context, an important and increasingly urgent challenge for the financial sector is how to modernise the complex legacy banking technology infrastructure in a way that will allow it to embrace the opportunity to apply new and emerging technologies. Government has a leadership role in helping to promote technology research and greater understanding of the UK's financial services technology infrastructure needs. Indeed, in order to be a leader in FinTech, the UK needs to be a leader in research and development. This leads to our next recommendation, which is about research and skills.

Recommendation 3

Research Councils and Innovate UK should support research in all areas of FinTech, including big data, analytics, and the social and economic impacts of FinTech.

The UK should build academic and technology leadership in the FinTech sector. The Alan Turing Institute should be well positioned to take on a major role, working closely with universities and industry. A key enabler for this research will be access to world-class financial data sets. A FinTech Advisory Board working with Research Councils and Innovate UK would have a role in helping to inform the research agenda.

Work, People and Policy

The economic potential of FinTech is substantial. The use of FinTech in everyday business is growing rapidly, with significant commercial opportunities for innovators. FinTech also has the capacity to alter the financial interactions of individual consumers and families at home and in the workplace. It offers many promising new opportunities for UK businesses in international markets, building on the UK's comparative advantage in financial services and ICT. However, whilst there are many potential benefits, there are also significant risks, not only for individual workers and businesses, but also for policy-makers.

We have explored both benefits and risks, focusing on the workplace, education, financial inclusion, and implications for regional and industrial policies, as well as monetary policy.

As well as creating new jobs, FinTech also has the potential to displace employees from existing jobs in the finance sector, so it will be important to have strategies to inspire and re-skill this displaced workforce and ensure a ready supply of skilled workers to fill new and different jobs. It is incumbent on the FinTech sector to make clear exactly what skills are needed. The technical innovators of the future will be the brightest minds, often educated in the core disciplines of advanced mathematics, engineering and computer science. There is no need for the introduction of a plethora of new courses in FinTech. What is needed is the introduction of optional modules in FinTech into the best courses in mathematics, engineering and computer sciences. Nor is the need purely for people with technical skills; what is needed is teams that combine technical wizardry with a broad range of business skills that have financial literacy at their heart, including product and service design, marketing, sales, communications, entrepreneurship and accountancy.

There is an important broader role and challenge for education. Financial illiteracy is a significant problem, particularly for vulnerable groups who do not have the

access or skills to harness online services or protect themselves effectively from fraud and exploitation. There is a risk that FinTech could aggravate financial and social exclusion, so industry and regulators will need to consider and ensure that those who introduce new FinTech products to consumers consider the potential for financial exclusion and respond appropriately. FinTech offers many possibilities for financial education and reducing exclusion. As one approach, games are being used increasingly as educational tools and could have a significant role in educating people about personal finance. Platforms already exist that help consumers track their spending, manage their income and understand their outgoings.

Other important policy challenges include privacy and security. A loss of trust in the conventional banking system may lead paradoxically to excessive trust in innovative alternatives, and this may be misguided. As one example, some approaches to crowd funding may encourage excessive risk-taking. In depersonalised online environments people are also more likely to defraud others and exploit behavioural biases.

Whilst FinTech is currently clustered in London and the South East this need not be the case for a primarily digital industry. And, as a global industry, FinTech is heavily reliant on a globally mobile workforce.

Central banks will play a key role in the emergence of some FinTech applications. Decentralised digital currencies have the potential to affect monetary policy implemented by central banks. Such currencies do not currently pose a material risk to monetary or financial stability and would have to be adopted on a mass scale before they could start to compete with Government-issued money. However, this is an area of FinTech where monitoring, research and scenario analysis are important as new threats and risks may emerge. Blockchain technology, developed alongside the development of digital currency, is a powerful tool for the creation of decentralised ledgers that could be valuable for future FinTech and, indeed, for asset management in areas outside finance.

Recommendation 4

Horizon scanning will be essential to anticipate, monitor and assist in the management of emerging risks and threats in FinTech. There is an important leadership role for a FinTech Advisory Group working closely with regulators and the Bank of England.

Recommendation 5

FinTech modules should be included in relevant degree courses to expose students to the FinTech industry and in turn to expose the FinTech industry to an educated and work-ready body of students.

Recommendation 6

Government should consider developing action plans to harness opportunities to develop regional hubs for FinTech outside London and the South East.

Recommendation 7

Government must be an expert strategic commissioner of FinTech. It should encourage all entrants to market, from start-ups to established players.

Government is an important purchaser of technology and has an opportunity to encourage innovation by expert commissioning of products and services.

We suggest that the SBRI programme, which is managed by Innovate UK, would provide a good starting point. SBRI is designed to enable Government bodies to connect with innovative businesses, finding novel solutions to specific public sector challenges and needs.

Business Models

FinTech is as much about innovation in business models as it is about technological innovation. Advances in software and other technological processes have enabled financial organisations to streamline operations and introduce new business models. This has led to disintermediation between front, middle and back offices. Technology is also changing customer behaviour, and in turn customer behaviour is leading to the reconfiguration of business models and of the entire industry.

New technology is opening up the financial services industry to new entrants. These include businesses from other service sectors that bring with them new and more customer-focused business models, displacing traditional models of financial service provision and opening up the market to new consumers. The result could be a virtuous circle where new entrants create new markets for new consumers, which in turn fosters greater financial inclusion.

But there are significant risks associated with the opening up of the financial sector to new entrants. Examples include questionable practices by businesses offering ‘payday’ loans, and fraud and exploitation by ‘bad actors’ targeting poorly educated new consumers. This places a considerable onus on consumers to understand how to make informed, wise decisions. Regulators will have an important role to play in consumer protection as new ways of doing things will inevitably bring new ways to mislead or defraud the public or destabilise the system.

One challenge is to create regulation for new businesses and business models in a rapidly changing environment in a way that is strong enough to promote system safety, whilst flexible enough to foster innovation and growth. This issue is tackled below in the section on regulation and has an associated recommendation.

The second challenge is to provide ‘laboratories’ for the development, demonstration and piloting of new FinTech business models. Early development can occur without the direct participation of consumers or business partners by means of computer modelling. This can happen in an academic or business environment and here again the Alan Turing Institute and the broader academic sector could provide a facilitatory environment.

But there is also significant potential to adopt a key mechanism from another industrial sector – pharmaceutical and medical devices. This is the ‘clinical trial’. New approaches in biomedicine are piloted and studied by means of trials that are regulated by the MHRA, the Medicines and Healthcare Products Regulatory Agency. This is an approach that could be used in the FinTech sector, in which new FinTech technologies or businesses could be piloted with actual retail consumers or business customers, subject to ethical approval, an agreed

protocol, provisional licensing and detailed oversight from regulators. This leads to Recommendation 8.

Recommendation 8

A system should be developed and overseen by financial regulators, learning from sectors such as the pharmaceutical sector, that allows new ideas to be piloted, and new technologies and consumer propositions to be tested in virtual and real situations without the threat of destabilising financial systems or jeopardising consumer protection.

Globalisation and UK FinTech

Over the past 200 years the UK has defined, shaped and now dominates the global financial industry and has been at the head of financial services innovation, including ICC and UCP Rules, international correspondent banking and more recently the Faster Payment Service.

The UK has significant competitive advantages in the field of FinTech that make it a natural candidate to take a global lead and flourish. These include: London's position as a world-leading centre for financial services, a world-class UK science base, an optimal time zone, business-friendly legislation and oversight, and use of English as the international language of business. These factors provide an opportunity for the UK to harness and make the most of valuable new sources of economic activity as new financial models emerge and take form.

However, these attributes are currently not optimally coordinated to create the best opportunities for FinTech. For example:

- The link between academia, investment and business has in the past been weaker than in other leading FinTech centres such as California.
- The considerable speed of FinTech innovation and development makes it difficult for regulators to keep pace with change and establish governance models that strike the right balance between systemic control and promoting continual reinvention and improvement.
- There is under-engagement between the UK FinTech industry and the international technology community, resulting in missed opportunities to take global leads and boost the UK's global presence in FinTech.

UK Trade and Investment, working closely with the Department for Business, Innovation & Skills, is well positioned to tackle these issues.

Recommendation 9

UKTI, working with BIS, should continue to develop the UK as a global hub for the FinTech innovation community, in order to attract innovators to the UK, retain them, lead in the creation of new sustainable financial services models and promote UK solutions and innovations in finance worldwide.

This has to be a long-term priority for UKTI, which should continue to focus on efforts to improve in these regards and find ways to monitor and improve on these goals.

Additional actions to achieve this could include:

- Nurturing international ties between the UK and other world-class FinTech centres (e.g. Singapore, Mumbai and San Francisco), working with the Foreign and Commonwealth Office.
- Promoting sustained inward investment.

RegTech: The Future of Financial Regulation

In order to make the UK a global centre for FinTech that supports the interests of consumers and businesses it is vital to have in place an effective and innovative regulatory regime. A careful balance needs to be struck between regulation, innovation and stability. There is an opportunity to get regulators, financial institutions, FinTech companies and universities to work together with the aim of promoting both innovation and regulation.

A key message is that the UK's regulatory system is exemplary in recognising the interests of new players, disruptors and innovators, and serves as a model for other systems globally, as it is home to an estimated 50% of FinTech start-ups in Europe. An excellent example of good practice is 'Project Innovate', led by the Financial Conduct Authority (FCA). This aims to promote innovation by identifying and remedying policies and processes within the regulatory system that are obstructive to innovation. Work of this sort presents the UK with an opportunity to lead the way and set a global example in the regulation of FinTech.

But there are additional opportunities to use FinTech as tools to improve the process of regulation. FinTech has the potential to be applied to regulation and compliance to make financial regulation and reporting more transparent, efficient and effective – creating new mechanisms for regulatory technology, 'RegTech'. Regulation is increasingly an EU and global process but the effective development and application of RegTech could create important opportunities for the UK in a potentially large new market. We have already suggested RegTech as a possible grand challenge but this will only provide a catalyst. To achieve the full potential of RegTech it will require the regulators (FCA/Prudential Regulation Authority) to work in collaboration with the FinTech and academic communities to realise the opportunity and achieve lasting change and benefit for the UK.

Recommendation 10

Regulators should engage the FinTech community in automating regulation and compliance to create a state-of-the art regulatory reporting and analytics infrastructure, which we have called 'RegTech'.

We suggest that initiatives such as Project Innovate could be used and adapted to find ways of commissioning, testing and adopting new innovative RegTech solutions.

Conclusion

Innovations in financial technology have the potential to completely redefine the financial services sector. Wisely applied they could help to re-establish trust in financial services while opening up financial services to a vast number of

un-served or under-served consumers. FinTech has potential for far-reaching impact, empowering consumers and businesses to play an active role in lending and borrowing through peer-to-peer networks, educating young people about personal finance through apps and games, helping consumers manage their own finances and freeing up surplus capital to invest in small businesses, good causes and venture philanthropy projects. In short, FinTech can democratise financial services.

However, there are also dystopian scenarios for the evolution of FinTech, with the possibility of increased financial exclusion and exploitation of large numbers of people, new opportunities for financial crime, and destabilisation of existing mechanisms that provide monetary policy and stability.

The UK's competitive advantage and thriving FinTech sector mean it is well placed to lead the world in FinTech. The prize for the UK is big and the risks of not succeeding could be far-reaching. In the near term, innovation activity could leave the UK; in the mid-term new disruptive services will be created by FinTech communities outside the UK that will be implemented in the UK; and in the long term, the financial business sector could drift from the UK to other countries around the world.

This review provides ten recommendations for Government, academia and the FinTech sector to help cement the UK as a world leader for FinTech. They provide a mix of long- and short-term actions ranging from the recommendation for a grand challenge programme, which could be implemented immediately, to longer-term structural changes such as the recommendation for the development of RegTech as a means of effective regulation in a world of gigantic data sets and globalised financial services.

Government has an important leadership role to play in helping to articulate the vision for FinTech, and working with industry and academia to catalyse its implementation. However, ultimately it is industry and regulators, working effectively with researchers, innovators, entrepreneurs and investors that will determine the future of the UK financial services sector. Success is most likely if the businesses that implement FinTech innovations, the regulators and central banks that oversee the resulting businesses, and the academics that carry out research into the financial sector play their part by working together in a responsible and collaborative way.



Vision

The UK will be the premier location for starting, growing and retaining innovative financial technology businesses. The UK environment will provide outstanding access to leading academic talent, investment and facilities and promote global thought leadership on emerging digital solutions. It will provide unrivalled international connectivity, a regulatory environment that balances risk and innovation, and will foster and maintain the optimal conditions for growing businesses.

Chapter I: Vision

Summary

The innovations emerging from the FinTech sector carry enormous transformative power. If the UK is to ensure the risks are mitigated and the potential realised, business models may need to evolve, incumbents may need to innovate, and policies may have to be adapted. Arguably the biggest risk is of not taking the opportunities provided by FinTech. Policy-makers, consumers and businesses need to be aware of the potential risks from mass adoption, from job displacement to data breaches. Mechanisms for mitigation of these and other risks could include effective and dynamic regulation, holistic financial education and greater competition.

Opportunities and Threats

When thinking about change on the scale presaged by these new financial tools and structures it is hard to avoid becoming wedded to overly simplistic visions, either of utopian or dystopian futures. In reality, the new FinTech landscape will present us with good and bad at the same time – winners and losers both living in the same future. This chapter provides a summary of the opportunities and risks that are presented in subsequent chapters and provides the Government with a vision to help it cement the UK as a world-leading environment for innovation.

Openness and Transparency

Open source has become a major force in technology and software development and many of the same principles are now being integrated into the business models of new FinTech start-ups, bringing with it the potential for greater openness and transparency. For example, OpenFin¹ is a start-up that provides runtime technology for financial desktops. Based on Google's open-source Chromium project, OpenFin's technology enables financial applications that are instantly deployable, interoperable and cross-platform.

Openness and transparency are positive attributes with potential for consumers empowered to manage their own personal financial data.² But with these benefits come risks around data privacy, accountability and the risk of data breaches.

Financial Literacy

Consumers in the UK are increasingly computer literate but financial literacy is still a problem for some, and one that FinTech could help solve. Technology-assisted approaches such as gamification may help. FinTech can create greater consumer empowerment but cannot eradicate consumer risk, particularly if new forms of finance become available and consumers are given more responsibility for managing their own money and data. Chapter 3 goes into more detail on issues of financial literacy.

Connectedness

Consumers are becoming increasingly connected and tech-savvy, which may present more opportunities for start-ups to win customers while also making it harder for large³ incumbents to maintain their market share. So far,

it is largely early adopters that have embraced peer-to-peer financial models, but as technology becomes more ubiquitous other consumers could follow suit,⁴ recognising peer-to-peer lending (P2PL) as a form of alternative finance that is a valuable source of funding or investment opportunity. Collaborative consumption, which is gaining popularity in other sectors, could also spread to financial services, leading to new collaborative models of finance such as group financing and peer-to-peer insurance. Peer-to-peer finance does however have its own risks and these are explored further in Chapter 4.

The adoption of smart devices could be widespread in the UK within the next few years. The Internet of Things will mean a growing number of devices beyond computers and smartphones will be connected to the internet. This will allow an almost real-time interaction between consumers and their financial services. However, it is important to remember that very few technologies reach 100% penetration. There will always be a proportion of the population who do not use such devices, either through choice or through circumstance. A recent study by the FCA predicts that smartphone penetration in the UK is likely to saturate at 95%, possibly less.⁵ The FinTech sector will need to ensure that the proportion of the population who do not use smart devices will not be excluded from accessing financial services. This includes ensuring sections of society are not excluded from the mainstream due to lack of skills or resources, effectively leading to 'digital exclusion'.

Supportive Regulations

In addition to new technologies, ubiquitous connectivity and growing consumer demand, the future of FinTech will require a pioneering regulatory framework that is agile, iterative and principles-based. In addition to enforcement, regulators could serve as supporters and guides, helping new FinTech start-ups navigate the regulatory landscape⁶ while ensuring products and services are fair, reliable and consumer-friendly. Such a regulatory environment could lead to increased business growth and access to new business models, which in turn may generate greater tax revenues that can be invested back into regulatory improvements and supportive initiatives like the FCA's Project Innovate.

FinTech adoption rates by consumers and businesses have a range of possible outcomes. Adoption rates could be unnecessarily limited either by too little regulation or too much. Striking the right regulatory balance between innovation, adoption and consumer protection will enable the UK's FinTech sector to grow rapidly and safely. Regulation is discussed further in Chapter 6.

Vision for the Future

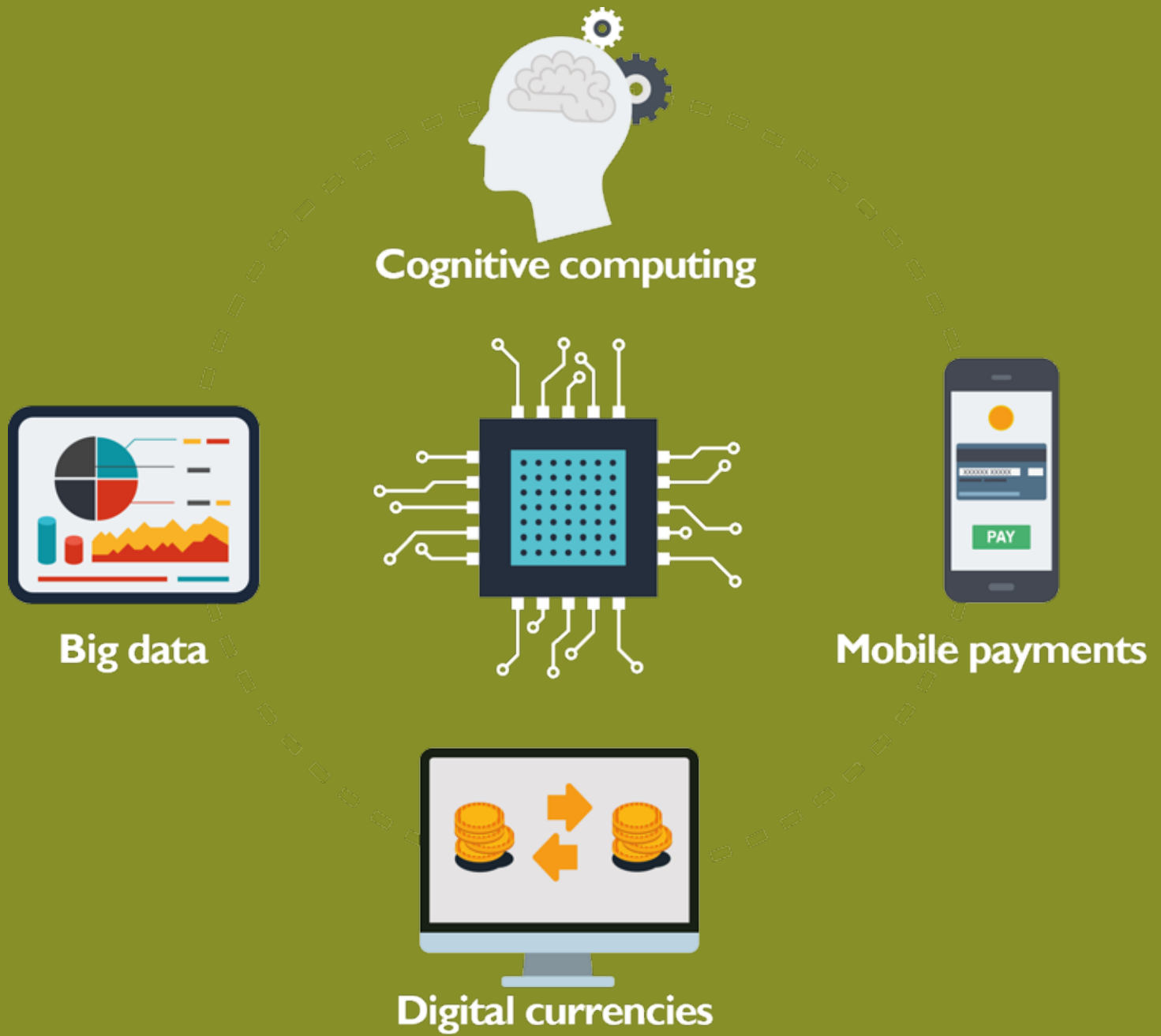
We have already touched on some of FinTech's potential benefits, from greater openness and transparency to the proliferation of new business models. In addition, the future may see more jobs⁷ created in financial services and associated sectors, while cloud computing may lead to falling IT costs even as output rises, leading to increased productivity in the sector and rising gross domestic product (GDP).⁸ FinTech could also play a role in reaching the 2.5 billion unbanked around the world,⁹ by offering mobile payments and microfinance solutions to ensure financial inclusion when traditional banking is unavailable or inaccessible. In the UK, FinTech could offer alternative financing solutions to

SMEs excluded from traditional financing options, with the potential to lead to business growth and increased entrepreneurship.

The balance of these factors gives rise to a vision for UK FinTech, which is:

“The UK will be the premier location for starting, growing and retaining innovative financial technology businesses. The UK environment will provide outstanding access to leading academic talent, investment and facilities and promote global thought leadership on emerging digital solutions. It will provide unrivalled international connectivity, a regulatory environment that balances risk and innovation, and will foster and maintain the optimal conditions for growing businesses.”

The role of Government is to provide the leadership and catalysis to achieve this.



Technology

Technology changes will enable new practices, business models and, in the law of unintended consequences, threats that have not been seen before. At one end of the spectrum, there will be outcomes causing extreme changes such as another ‘iTunes moment’, forcing radical industry change and undermining current market leaders whose relevance and market share declines. At the other end of the spectrum, the outcome will lead to new services and advanced optimisation of existing services.

Chapter 2: Technology

Summary

Technology changes will enable new practices, business models and, in the law of unintended consequences, threats that have not been seen before. At one end of the spectrum, there will be outcomes causing extreme changes such as another 'iTunes moment', forcing radical industry change and undermining current market leaders whose relevance and market share declines. At the other end of the spectrum, the outcome will lead to new services and advanced optimisation of existing services. In either scenario, one could expect a major impact on the geographic siting of financial institutions, with its knock-on effect on employment and on institution-specific models. The skills required for employment in the sector will start to shift: already there are changes coming through with the move from banking at branches to ATM machines, online banking and call centres. In financial markets, significant volumes are now traded by computer algorithms and hedge funds, which are rapidly changing the dynamic of institutions. The complexity of the financial system is also driving changes around compliance and risk management, which will probably require both mitigation of the effects of technology, and technology itself to address. There are four key groupings of technology advancements.

Machine Learning and Cognitive Computing

Rapid advances are being made in computer systems that can learn from algorithms, as opposed to simply being programmed to do certain tasks. This means that many tasks which previously required human input can now be done by computers alone, much more quickly and with greater accuracy.

- Cognitive computing, and artificial intelligence to some extent, is the next era of computing. There is movement away from the programming era to the cognitive era, and this will develop through a number of stages: *Assistance* where computers use and leverage massive domain knowledge in context; *Understanding* where computers decipher models and systems; *Decisioning* where computers are capable of semi-autonomous unbiased advice, in support of human decision making; and *Discovery* where computers can offer new insights and new value.
- Early applications of this technology can understand language, learn with experience and describe evidence.

Financial services can potentially be transformed by cognitive computing. New wealth management and financial advice capabilities will empower customers with proactive personalised advice to achieve their goals. Financial analysts and advisors can take advantage of every new piece of information, and risk management can be transformed by evaluating all instances against approved policies and procedures. Demand for roles such as call centre staff may be reduced as a result of these technologies.

Digital Currencies and Blockchain

Digital currencies such as bitcoin have the potential to replace traditional currency and, by extension, the need for central banking and regulatory systems.

Bitcoin is an internet-scale open platform for value exchange with near-instant, near-free international value transfer requiring no central clearing. Bitcoin and other digital currencies may be unpredictable given the lack of central and regulatory systems, but in the event of widespread adoption would be a major challenge and raise questions around taxation and regulation. The opportunities in financial services range from re-architecture of the securities market, supply chain finance, programmable money, and push payments by design. It is also important to acknowledge the threat bitcoin creates for facilitating money laundering and funding illicit activities (e.g. the Silk Road site that used bitcoin for payments for drugs and prostitution). See Case study 1: Blockchain technology for more information.

Big Data Analytics, Optimisation and Fusion

Big data refers to both the information that companies hold, as well as the activity logs that take place on their systems. As computer storage becomes cheaper, and as analytic software becomes faster, huge gains are to be made in information gathering and new businesses are emerging as a result of new insights and the cross-referencing of information.

- Data-centric computing – a major part of computing today is data, and systems are working on persistent peta-scale in memory data, volumes and speeds not conceived of even a decade ago. This has led to striving for real-time everything, with data scientists having to reinvent and create new data structures. The era of the structured database is ending, and data has to be defined and cleaned as it is used. Vast data lakes are being created where data is stored in its native format until it is required for use. Enormous amounts of data are stored in the cloud, with a variety of analytics being performed on it. The implications of data-centric computing for the financial services industry are varied. This includes technology demands on incumbents continuing to increase and new players entering with an advantage because they can build nimble architecture on day 1.
- Data management – the amount of data stored is increasing exponentially as storage systems become cheaper, but it is still problematic gleaning insight from these vast troves of information. This situation is improving, however, driven by a realisation that this data can indeed provide more insights and even opportunities for monetisation. Financial institutions in particular have to mitigate the impact that analytical silos have in their institutions today. The midata initiative launched in 2011, which aims to give consumers access to data companies hold on them, could in fact prove to be a game-changer in this field.
- Application programming interfaces (APIs) – these are changing the face of development and the way products and services are delivered to consumers and businesses and have the potential to create new brand exposure and sources of revenue, as well as fostering new affiliate and distribution models. APIs allow companies to open their resources in a secure and controlled way as they create almost real-time access to assets across different divisions.

Distributed Systems, Mobile Payments and Peer-to-Peer Applications

- Digital (not just mobile) payments – the ‘consumerisation’ of technology is driving change, from contactless payment systems to the new Apple Pay. Customer experience is now at the forefront when considering new technologies that provide more convenience and improved fraud protection. In the long term, wearable or possibly even haptic technologies could provide opportunities and speed up transactions.
- Peer-to-peer lending (P2PL) – in the last few years, there has been an explosion in alternatives to traditional bank lending, both for individuals and for corporates. Government is committed to further support P2PL and crowd funding through a package of measures to remove barriers to their growth (regulation and tax rules). However, regulation is still developing and there is fear from peer-to-peer businesses that regulation could deter the crowd. There is a question of how different such schemes truly are from existing solutions if the same regulatory safeguards were applied.

Future Technologies

Envisioning the future one can imagine systems allowing continuous analytics, not just learning what is already within these systems but creating new knowledge. The Internet of Things is rapidly developing into real-world usable objects. The Semantic Web will allow the sharing of content beyond the boundaries of applications and websites. Continuous technology discoveries and advancements will enable rapid adoption of new industry capabilities and services, and there are ongoing advancements in chip design and high speed/low power transistors.

- Quantum computing is probably a decade or more away from a true working adoption. In the UK there is the opportunity to leverage the national network of Quantum Technology Hubs, funded by the Engineering and Physical Sciences Research Council (EPSRC). These hubs will explore the properties of quantum mechanics and how they can be harnessed for use in technology. As an example quantum information processing could solve big data issues in a fraction of the time that even today’s massively scalable supercomputers cannot achieve. In financial services this could provide new approaches to portfolio optimisation, and personalised advice. However, in some experts’ views this disruptive technology could undermine completely the cryptographic algorithms that underpin the internet today. If so this will have serious implications for payment systems, for example.

Financial Services Challenges

Current technology and information systems are in silos, oriented around products and past acquisitions. Independent silos drive replication and inefficiency, silo processing is difficult to change, and it is expensive to add and achieve regulatory compliance. The common thinking is that change will be incremental; banks have little appetite to replace their current infrastructure. However, data and analytics driven systems can support new products alongside the old ones.

Challenger banks, non-bank and shadow banking new entrants will potentially be less constrained by 'legacy systems' enabling them to build, or buy as a service, highly scalable systems, with controls and analytics, and potentially superior customer value.

Case study 1: Blockchain technology

The financial crisis has driven the rapid development of alternative financial services models, including digital currencies. These technologies have the potential to fundamentally reshape and replace existing mechanisms for the storage and exchange of value.

More interesting in the long term and in the context of disruptive FinTech is the ability to reduce the complexity and cost to connect multiple parties to a single agreed digital record shared by all and available in near real time. Collectively the technologies underpinning digital currencies are referred to as 'decentralised consensus ledgers'.

A well-known example is the bitcoin ledger, blockchain. Any document can be digitised, codified and inserted into the blockchain, which becomes a record that is indelible and cannot be tampered with. It has the potential to change a number of transactions including international payments, asset transfers or securities clearance by providing access to a database that is distributed across the internet but remains secure. The potential benefits of this new model include improved speed, efficiency, reduced cost of operation and the elimination of single points of failure from the system.

The potential is to remove the need for complex hubs by enabling each network participant to have, in near real time, a copy of the agreed ledger. The most mature approach has come from the community associated with bitcoin and blockchain. However, a number of other approaches are also under way including Ripple (USA), Open Transactions (Switzerland), and Ethereum. Decentralised consensus ledgers are not synonymous with bitcoin blockchain.

The potential value to the UK is much greater than FinTech alone. Every institution and individual in the UK is economically active and all parties exchange payments and transaction data when they buy or sell goods and services, get paid or pay taxes.

However, there is a danger that regulatory uncertainty could inhibit progress (although this is a global as well as local issue); therefore investigating the opportunities and risks of blockchain technology in its own right would be prudent.

In order for UK FinTech and the UK economy to benefit from these emerging capabilities a number of the recommendations in this review would be helpful. These include coordination of academia, business and regulatory efforts, and the ability to move from concept to trial in a safe and cost-effective manner. In addition the wider use of the core technology across government and finance is worthy of further exploration and may be one of the questions addressed to the proposed FinTech Advisory Panel.

Simon Bailey – CGI Group

The cost of existing IT may be significant for future business models. Structural and technology change will be important. If this change is achieved it could:

- Provide new opportunities in the marketplace and business models.
- Address new forms of competition such as Apple Pay that successfully compete with traditional banks.
- Deal with stranded costs in inflexible legacy infrastructure.

Opportunities for Innovation/FinTech

There is an opportunity to apply new and emerging technologies to enable the financial services industry to adopt scalable, versatile data architectures, customer-centric services and products, and secure, agile infrastructures to address these challenges head on. Financial services and banking is an information-product industry and as such highly sensitive to change driven by advances in cognitive computing, analytics, optimisation, social networks and contextual capabilities. Improvements in processes and systems across the financial services value chain can significantly improve efficiencies, and lay the foundation for modern, secure knowledge-based systems. Data-dependent intelligence is the future, and emerging technology can help.

In order to make the most of these opportunities Government could take the lead by commissioning a 'digital modernisation strategy' for and in collaboration with the financial services industry, to determine what desirable components make up the UK's critical national financial services technology infrastructure and possible gaps, threats and opportunities. The financial services industry is facing both transformational challenges and threats of disintermediation with the complexity of banking technology infrastructure representing a challenge to modernisation. A 'digital modernisation strategy' would help to reduce the drag of legacy and complexity of technology infrastructure.

Case study 2: Cloud computing

Cloud computing is allowing businesses to become more integrated online. A growing number of businesses are using Software as a Service (SaaS) models. Increased value of the cloud lies in the enforced simplification of IT – it allows companies to scale their business without having to make massive up-front investments, and has the advantage of being available immediately. Many IT solutions today are only available in the cloud, such as DeskAway and Salesforce Customer Relationship Manager. The further development of cloud technologies will also be a major driver for legacy system renewal.



Work



Policy



People

Work, People and Policy

Just as the internet and online social networks have had an impact on social behaviour and communication, financial technologies have the potential to affect many aspects of everyday life. FinTech could pose challenges and opportunities for the UK workplace, education and financial inclusion, and has implications for regional, industrial and monetary policies.

Chapter 3: Work, People and Policy

Summary

The use of FinTech in everyday business is growing rapidly, with significant commercial opportunities for innovators. Just as the internet and online social networks have had impacts on social behaviour and communication, FinTech has the capacity to alter work, learning and business. FinTech offers many promising new opportunities for UK businesses in international markets, building on the UK's comparative advantages in financial services and ICT. However, there are potential drawbacks, not only for individual workers and businesses, but also for policy-makers. This chapter explores some of the potential, and pitfalls, focusing on workplace, education, financial inclusion, implications for regional and industrial policies, and monetary policy.

FinTech in the Workplace – Productivity and Employment

Technological progress is a theme well explored by economists and some basic economic insights can be applied to FinTech. Economists use the concept of a 'production function' to capture the ways in which labour and capital come together to produce output for a given level of technology. Labour and capital may be substitutes, complements, or something in between. In the case of substitutes, when one factor is relatively cheap, it will be used more intensively in production. For example, when the costs of investing in physical capital, including machinery and equipment, decrease (e.g. when borrowing costs/ interest rates decrease), businesses move away from using labour towards more capital-intensive production. When labour is relatively cheap, wages are lower, and production becomes more labour intensive. Sometimes, however, it is not easy to substitute capital for labour and vice versa; they are complements. For one factor to work it requires the other factor – for example, computers and workers are complements in many businesses: if a business invests in an extra computer, an extra worker is needed to use it. Similarly, there is no point in employing an extra worker if you do not have a computer for them to use. In the real world, labour and capital are something in between – there is a degree of substitutability as the relative price of labour and capital change.

Whether or not labour and capital are substitutes or complements is a crucial question when assessing the likely labour market impacts of FinTech. An example of financial innovation that *complements* labour, boosting a worker's productivity without costing them a job is the Faster Payments Service. Suppliers and workers can be paid more quickly, boosting the productivity of accountants and others, leaving them free to devote more time to other tasks. If FinTech improves overall business performance significantly, then business will grow; its demand for labour will grow, and employment will grow. Self-checkout in supermarkets is an example of financial innovation that *substitutes* for labour. The self-checkout machines replace workers – and most supermarket cashiers will not have alternative tasks to fill their time if the customers are using self-service checkouts (apart from those helping customers struggling to use the machines).

Technological progress introduces another element into the production function. Technology interacts with both factors of production and can boost the productivity of both capital and labour together; it boosts ‘total factor productivity’ (TFP). Large technological changes feed through into significant structural shifts in the economy – and structural change will have wide-reaching consequences, good and bad. Innovative FinTech could enable workers to do more in less time, boosting productivity. More productive workers are more attractive to employers and so technological progress boosts labour demand. Assuming that workers are paid according to their productivity, then wages will rise as productivity rises, potentially boosting living standards and well-being, as well as contributing additional tax revenue to the Exchequer. The possible pitfall, however, is that human requirements for low-skilled jobs are reduced. For example, service call centres are replaced by online chat and online access to FAQs. This could create short-term/long-term tension. In the short term losing a job is painful, but in the long term it frees up human capital and ‘pulls’ it towards higher-skilled, higher-valued jobs, especially if retraining is available.

What then are the practical implications of FinTech for real-world labour markets? If new technologies are associated with replacing labour, this may contribute to joblessness and/or lower labour productivity and concomitantly lower wages if workers are displaced to unskilled jobs. At worst, it could displace workers who do not have the skills to enter alternative occupations, leading to wage inequality between the skilled computer-literate workers and unskilled manual workers. It may exacerbate long-term unemployment and intensify a range of related problems, for example skills atrophy, discouraged workers or benefits dependency. The prospective trade-off is higher productivity and wages for the workers who do have a job. If productivity increases via increasing labour productivity or TFP, the economy overall will grow as production and employment grow. Wages will rise, contributing to increases in living standards. What is important for FinTech growth and to abate extreme job displacement is education and skills development to support FinTech at all levels.

Alternatives to Employment

FinTech specifically, and the growth of the internet generally, have supported the growth of new alternatives to traditional employer–employee relationships, including self-employment and entrepreneurship. FinTech has also enabled the development of new business models (discussed further in Chapter 4), which have facilitated a reduction in the impacts of the recent recession on unemployment. This supported new businesses and shifted people towards self-employment after redundancy. For example, TaskRabbit in the USA mushroomed when out-of-work people offered to run errands and do simple tasks (e.g. assemble IKEA furniture) for others. Airbnb and Onefinestay (UK) got a boost from ordinary citizens who were willing to open their own homes, holiday homes or cars for a bit of extra cash. The freelance/self-employed pool grew dramatically when traditionally employed people were laid off. They had new tools at their disposal, i.e. eLance/Odesk and other skill-sharing sites which enabled unemployed professionals to work on a project basis for scaled-down companies. Working in this way provided many with a new level of flexibility. As long as the short-term vulnerabilities that unemployment and redundancy may create are addressed via good safety nets, downturns can encourage

resourcefulness, and efficient and cost-effective models; these benefits may carry over during boom times.

Another significant development is in the provision of otherwise unaffordable private sector financial infrastructure for small players. Examples include eBay, PayPal, Airbnb and Uber. A small business could not necessarily by itself afford the substantial sunk costs associated with starting a new business. Even if it could, it would be difficult to achieve the large volume of sales needed to leverage the economies of scale offered by innovative and capital-intensive online payments systems. FinTech has enabled a structural shift towards a business model of shared financial infrastructure. Thus FinTech enables the development of competition in other industries, as small players are able to challenge large firms – for example Airbnb provides ordinary householders with the capabilities to manage their room bookings via a secure, trusted and reliable payment system, and without this they would not be able to compete with large hotel chains. To continue these trends and see growth in FinTech spaces, financial (loans) and business support for FinTech entrepreneurs, start-ups, SMEs and the self-employed is desirable, especially in regions outside London and the South East.

Education, Information and Financial Inclusion

The financial crisis and subsequent recession eroded the public's trust in traditional financial sectors. In the build-up to the crisis a complex set of influences were relevant but a small part of the problem was financial illiteracy. Short-termism and/or excessive optimism among ordinary borrowers led people to borrow money that they were not able to repay. FinTech sharing models such as crowd funding have the potential to stimulate financial and economic inclusion similar to Airbnb and other sharing services, although the fallout from recession has seen the rapid growth in exploitative payday lending practices. Financial illiteracy is still a significant problem today, particularly for vulnerable groups who do not have access to financial safety nets. Technical and computing illiteracy is problematic for vulnerable groups who do not have the skills to harness online services and/or protect themselves from online fraud and exploitation. Demographic patterns are variable in terms of these vulnerabilities. A recent ONS report found that 99% of 16–24 year olds had used the internet, compared with 37% of adults aged over 75.¹⁰ A recent ComRes survey for R3 (the Association of Business Recovery Professionals) found that 26% of 18–24 year olds are likely to take out a payday loan in the next 6 months, relative to 4% for people aged 45 and over.¹¹

Cashless payment systems and electronic transfers offer potential solutions to exploitation. Mobile payments for instance have three main advantages – they permit better self-monitoring of spending, they can help householders to more efficiently manage their household finances by enabling transfers of small sums of money, and they enable the opportunity to use micro-payments to harness micro-savings, all through consumers being better able to track their money. This could provide a less exploitative substitute for payday loans. This could also provide people living in countries that do not have well-developed traditional financial infrastructure with innovative vehicles for saving as well as borrowing; potentially complementary to the UK's international aid goals. There are commercial opportunities to provide more of these services worldwide,

although it is important to ensure that commercial interests are balanced against the interests of ordinary consumers and taxpayers.

The FinTech sector also has the potential to support financial education solutions. The growth of online courses has revealed new educational models – most famously MOOCs (massive open online courses). Financial education will succeed if it is engaging, stimulating and not intimidating, and traditional methods, even if offered online, may be unappealing to most people. The enduring popularity of Monopoly as a game illustrates the fact that people are prepared to engage with financial information if it comes in the right package. Computer gaming is a powerful way to help people to better understand their finances and has significant potential not only to help people manage their own finances but also to boost their productivity and skills in other areas too, potentially increasing their employability.¹² Therefore FinTech innovations and gamification have roles to play in financial literacy and education and could be seen as valuable assets in this area.

Privacy and Security

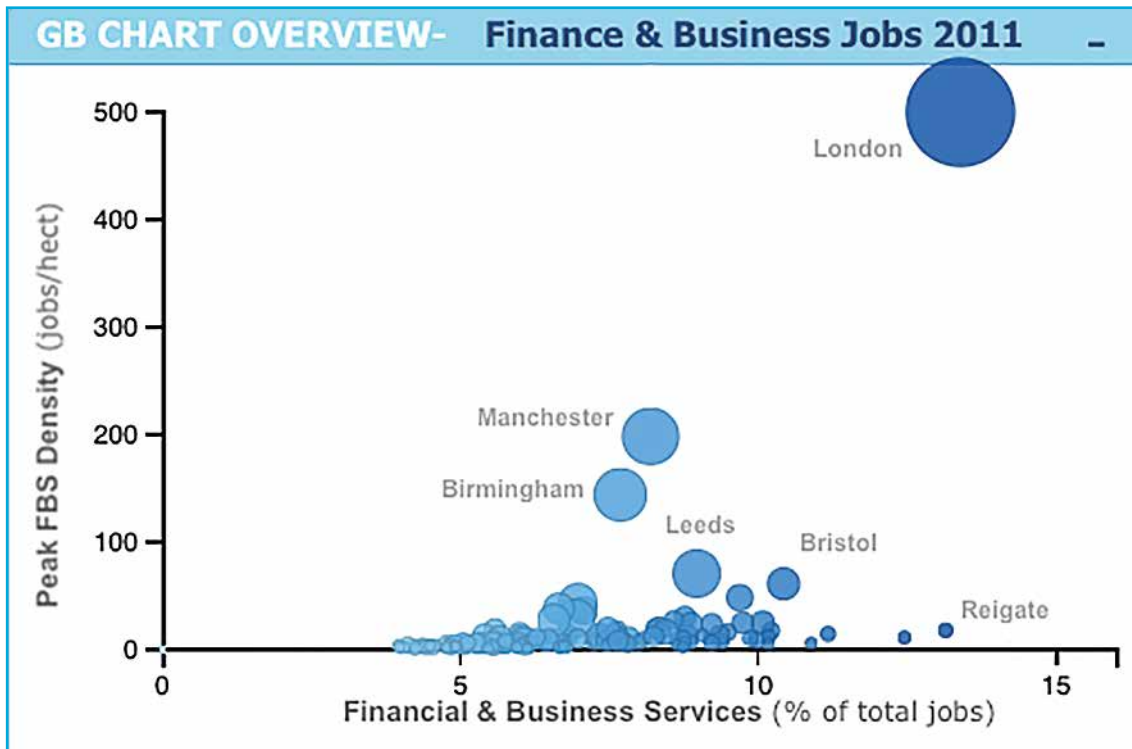
Loss of trust in the conventional banking system may lead to excessive trust in alternatives, and this may be misguided. Security of online transactions is not ensured and a key growth area of new FinTech is in finding more efficient methods for ensuring privacy and security. Current password technology is often inefficient, costly and ineffective, and people regularly make a trade-off between convenience and security – memorable passwords are insecure; secure passwords are easy to forget. So people write their passwords down, making them more vulnerable, or they forget their password and have to find themselves a new one. The process of re-setting passwords is time-consuming and is another opportunity for security breaches.

Online fraud is endemic and a wide range of scams have the potential to affect large numbers of people. In depersonalised online environments people may be more likely to defraud others – although FinTech has the potential to reintroduce a personalised dimension and/or create pressures on reputation via online social networks and social media. However FinTech has risks. For example crowd funders can exploit behavioural biases by setting low fundraising goals to encourage amateurs to invest when they see that a large proportion of the fundraising goal has been achieved quickly, without knowing that this was because the goal was set low – the ‘illusion of progress’. Developing FinTech to overcome some of these problems is a significant market and regulatory opportunity – which Government could promote, particularly to protect online privacy and security and reduce vulnerabilities to online exploitation.

Regional and Industrial Strategies

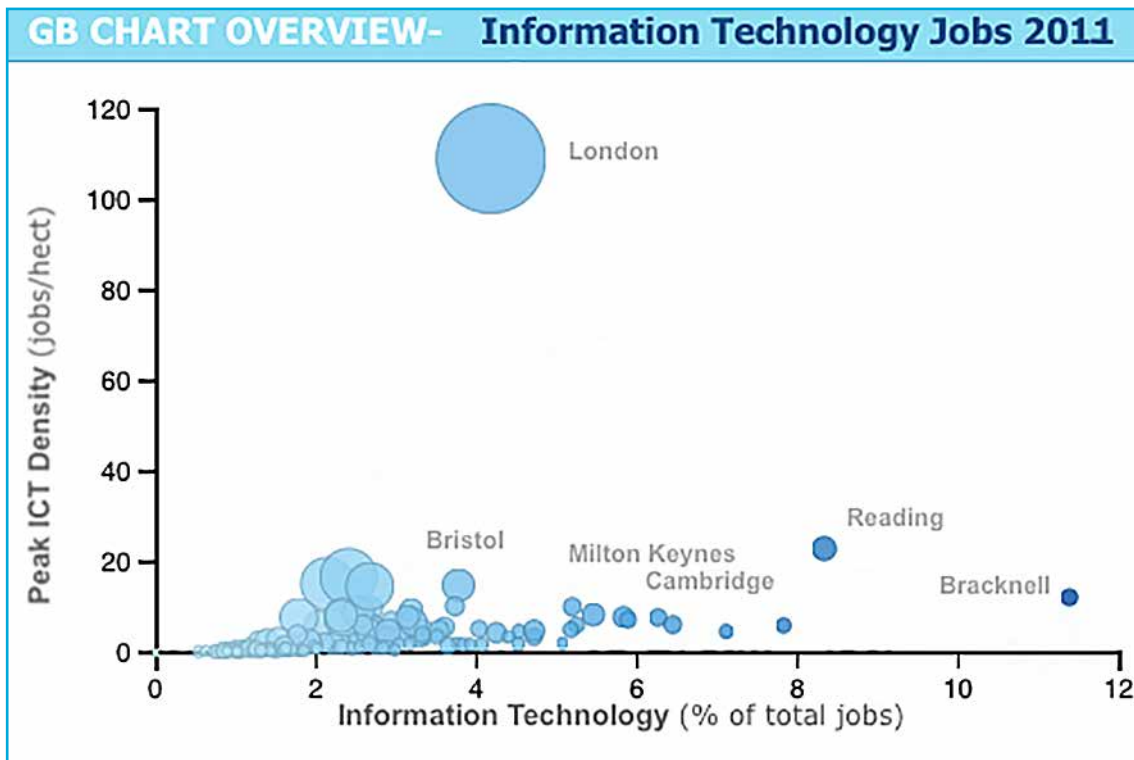
One potential pitfall of FinTech is that it might intensify the UK's reliance on the financial services sector – to be in a good position in the event of another global financial/economic crisis the UK might consider diversifying its industrial base. With careful thought FinTech could provide this but the focus ought to be on developing new avenues, and better linkages with other sectors and industries. The linkages could come in the form of collaboration, cross-industry lobbying, and FinTech players developing solutions specifically for non-financial services industries, e.g. healthcare, education, Government, etc. Another potential pitfall is that jobs in ICT and financial services are concentrated in London and the South East (see Figures 1 and 2). This is both a danger and an opportunity. Because innovative FinTech is a-spatial there is an ideal opportunity for financial and business support to incentivise businesses to shift to other regions, thus developing regional hubs outside of the South East – to complement investments in transport and other infrastructures such as HS2/HS3.

Figure 1: Regional dispersion of finance and business jobs, UK 2011¹³



FinTech could be guided to contribute to regional convergence, such as taking account of demographic, socio-economic and regional divides, thus avoiding further divergences and exacerbation of the concentration of economic potential and wealth in London and the South East. One potential way to kick-start a regionalisation strategy is to fund and/or capacitate specific universities to be research and expert centres in certain areas, and include innovation labs. Collocated with tech or tech-led companies, this could create a micro-hub rapidly. This was the model of Silicon Valley: defence firms filled with thousands of engineers, located near Stanford University. The virtuous circle created an innovation hub.

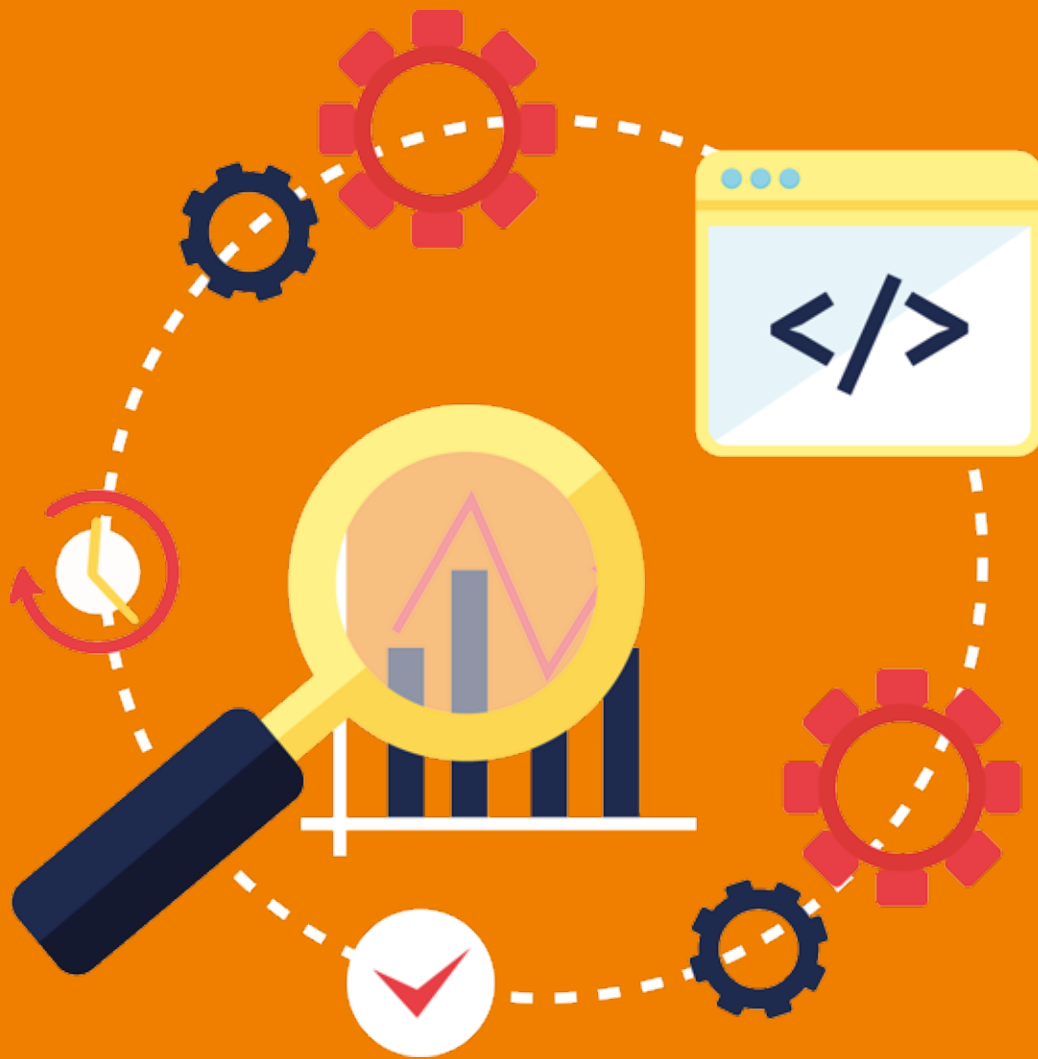
Figure 2: Regional dispersion of information technology jobs, UK 2011¹⁴



If FinTech is developed as an input into wide-ranging business activities – domestically, it will boost employment, productivity and growth; internationally, it will provide new sources of comparative advantage. Government-led industrial strategies could potentially harness these new opportunities. To achieve this, linkages with other industrial sectors could be widened and deepened. For example, in the construction and manufacturing sectors, businesses are increasingly using Building Information Modelling (BIM) – originally envisaged as an architectural solution, but now being developed as a financial modelling and planning tool, and Government procurement will require BIM from 2016 onwards.¹⁵ Increasingly, there are good opportunities for the FinTech sector to service other sectors via such tools, if financial support is provided and a good supply of skilled people is available. School and university education in science and engineering will be an important element of supporting the FinTech industry.

Monetary Policy

There is a range of potential ways in which FinTech might affect the conduct or transmission of monetary policy, or even (theoretically) the achievement of a central bank's goals, but these remain uncertain and not well explored. Early analysis by the Bank of England has suggested that existing digital currencies do not currently pose a material risk to monetary stability in the UK (for more detail, see the 'Risks to monetary stability' section of the Bank's Quarterly Bulletin article, 'The economics of digital currencies'¹⁶). But broader questions remain, and the Bank has incorporated questions related to digital currencies and alternative payment systems in its recently launched 'One Bank Research Agenda'.¹⁷



Business Models

Changes wrought by technology have transformed how institutions do business. This has allowed new business models to be created and old ones to be adapted. As the FinTech sector grows many new business models may emerge, allowing increased choice and flexibility for both businesses and consumers.

Chapter 4: Business Models

Traditional Financial Services Business Models

The current UK financial services industry is the result of innovation, regulation and technological change. Over time, some institutions have achieved global scale, wielding a greater amount of power, and becoming diversified in their operations. However the economic crisis in 2008 caused reduced trust in large, opaque and monolithic institutions. This, combined with exponential advances in technology, has led to an explosion of digitally-enabled, transparent, social-centric financial services and products being more and more easily adopted. After the crisis, regulators have been working towards penalising overleveraged banks, in an attempt to increase regulatory capital requirements and segregating banks' core 'safer' activities from 'riskier' higher return activities. At the same time, regulators recognise that innovators in the space need flexibility and guidance, in shorter time frames, and with a fraction of the compliance-focused manpower available to larger institutions. The UK's regulatory system is exemplary in recognising the interests of new players, disruptors and innovators, and serves as a model for other systems globally as it is home to an estimated 50% of FinTech start-ups in Europe.¹⁸

Historically, a current account was the only way that consumers could access financial services, serving as the basis for cash, cheque, savings, bill payments, loans and credit cards. Today, non-traditional actors in payments, savings, remittance and credit have replicated these activities. Smoother digital service means face-to-face transactions are on the decline, which creates opportunity for a variety of non-cash payment methods. As a result, payment method options have proliferated, and the value-add for both the merchant and the customer has been enriched with new services (e.g. monitoring, integration with other systems, expense management, data filtering, customised offerings). Banks no longer control all payment methods, and new non-financial services players such as Apple Pay are making serious bids on the banks' customer segment. Their business models are necessarily innovative and novel, and in some cases are cross-subsidised with other parts of their business, making the payments component cheaper.¹⁹

Changes wrought by technology have transformed how institutions do business, the number and shape of new businesses, and the rules of play for the market. Within incumbent players, technology has allowed them to deepen their service offering and lower their costs.²⁰ New entrants and players from other sectors have utilised technology to enter the financial services market in very targeted and narrow ways, avoiding both competition with large institutions and the need for difficult-to-obtain licences. These entrants often initially target areas of financial services that are under-served, inefficient or suffer from poor transparency or information. Profit results from a focus on efficient service delivery, or on enabling the flow of information. The premise of a lot of these models is serving a greater volume of comparatively low-value consumers, rather than fewer, high-value ones. This has resulted in a system that improves productivity and efficiency, promotes openness and transparency, and above all, drives forward financial inclusion.

Areas of inefficiency today include large intermediaries who profit from information asymmetry, unfair advantages, high barriers to entry, pricing differentials, and other areas driven largely by unconnected players in the market. For example a recent Competition and Markets Authority (CMA) report showed that 90% of business loans are provided by the big four banks.²¹ However, the entrance of new players could challenge the profitability of this model. Intermediaries will have to demonstrate that they add value in order to maintain relevancy and hence profitability as sharper market practices that enhance communication and connection put them under pressure. This creates both opportunities and challenges for new entrants to enter the market profitably, including how to foster a safe environment with low barriers to entry in financial services, and how to create a regulatory framework flexible enough to foster innovation, yet strong enough to deter fraud and failures.

Emerging Financial Services Business Models

Digital is being driven from nearly all directions, including from established institutions, new entrants and consumers, particularly consumer behaviour. According to Moven Founder and CEO Brett King, technology is rapidly changing customer behaviour, and in turn customer behaviour is leading to the inevitable reconfiguration of business models, as well as reconfiguration of the entire industry. The significant increase in the number of participants, as well as their interdependency, can foster and promote trust. Given that trust in the financial system plummeted during the financial crisis, high-trust systems can command a premium. Data collection, open platforms and the 'crowd' play a role in creating and enforcing trust.

- Retail banking – incumbents are pushing the digital agenda as a way to extend service delivery in a cost-efficient way, utilising digital to reduce costly infrastructure such as the branch network or customer service.²² They are moving forward by building their own new technology, collaborating with new technology players, or by acquiring a service or product which they have difficulty replicating. New entrants, in turn, are using cheaper and more efficient technology to exploit existing disadvantages of incumbents, many of which are bogged down by legacy infrastructure and regulation. For nimble new entrants, inexpensive cloud storage enables sophisticated data and analytics, social networking sites promote data sharing and integrated hardware and software solutions enable mobile payments.
- Capital markets and associated areas have seen the rise of digital-enabled new models such as high-frequency trading (HFT) and algorithmic trading. Firms utilise superior computing power and fast connection speeds to target market inefficiencies or exploit arbitrage opportunities. These now comprise nearly a third of trades on the London Stock Exchange, but despite possible increases in market competition, questions remain about market fairness, and their ability to destabilise the system and create 'flash crashes'.
- Insurance – the insurance industry is set to be rejuvenated by wearables, telematics and the Internet of Things; devices sending and receiving information about an individual's environment and habits. This data can link directly to insurance companies' systems, creating real-time pricing and policy opportunities. This removes a lot of the guesswork that traditional

predictive analytics has involved and creates a more personalised customer service.²³

- Non-financial services entrants could continue to consume bits of the financial services business, particularly payments. Apple Pay and Google Wallet have expanded into payments in order to facilitate their core business. These players make money from the volume or value of transactions, and often subsidise transaction costs with revenue from other sources. New payment models built on inexpensive platforms (e.g. mobile) within closed-loop systems allow for micropayments systems and have the potential to overcome some problems of conventional currency. Consumers of all income brackets can make payments for small amounts, as well as create micro-savings. The provision of new types of licensing, such as e-money licences, also stimulates this type of activity and innovation, permitting players such as retail brands and telecoms to conduct niche financial services activities.
- ‘New’ new entrants are beginning to enter the industry in a truly novel way. With access to superior technology, they exist to fundamentally circumvent inefficiencies in the system, often creating new financial systems of their own. Digital currencies such as bitcoin have been designed in such a way, while other blockchain entrants are looking to reinvent securities exchanges and asset registries. These innovations require no central authority, have limited central infrastructure (central switch) and therefore can be presented as extremely low cost.

Hyper-Connectivity and Communication

More and more people are now online and interconnected, fostering collaboration, communication and data collection. This increasingly puts pressure on players who rely heavily on information asymmetry, introductions or low transparency to capture value. New methodologies such as networks, ratings systems, marketplaces and other peer-to-peer networks means that consumers are able to share information and make systems as open as possible. The ability of incumbents to benefit depends on their starting business models. Insurance in the health sector is currently very well positioned to capitalise on this trend, as the rise of wearables and sensors can collect and transmit data that enriches risk models.

- Platforms are one area where new entrants have utilised hyper-connectivity to pair participants with one another for information sharing, collaboration, buying and selling, and other areas. These platforms create mini-ecosystems that can be monitored for data collection, or targeted for credit loans, on the basis of platform activity. For instance, Amazon and PayPal both extend loans to small suppliers on their platforms on this basis.²⁴
- Financial reporting and advice – asset management players such as pension funds, which currently have opaque pricing, may come under pressure to better report fees and underlying performance. In the Netherlands, a 2011 cost reporting mandate preceded a drop in pension fund costs.²⁵ Fund ratings site Morningstar has brought an unprecedented degree of transparency to pricing and performance of mutual funds.²⁶
- Automation – more activities allows cost reduction, process efficiencies, data

collection and faster payments in areas such as payments and invoicing, which in turn facilitates better credit scoring. New models such as invoice financing and supply chain finance (SCF) promote small supplier liquidity by lending against invoices to large buyers. These improvements are enabled by digital invoicing platforms.

- Alternative finance such as crowd funding has proliferated recently in the UK, and this sector was estimated at £1.74bn in 2014,²⁷ including donation and reward finance models. From financing consumer credit to SMEs investing or lending, these platforms also offer superior propositions, through greater credit or investment access, better returns for lenders, or better rates for borrowers:
 - Despite new models of intermediation, established players are not likely to disappear but rather seek new, higher-value ways to participate in the new system. Most crowd funding platforms were started to expand credit access to individuals and small businesses by removing financial institutions from the equation and allowing individuals to lend. Currently, institutional investors such as hedge funds are beginning to provide some liquidity and banks are partnering via referrals, augmenting retail lending in this more efficient channel.
 - One concern in particular is the threat of ‘crowd manipulation’ by bad actors on crowd funding platforms. While this is a valid concern, more participants allows better group enforcement of ethics and platform rules. The connectivity aspect of such platforms (e.g. ‘seller ratings’) allows for superior communication by those who have experienced fraud or other bad behaviours. This facilitates gathering of richer information, such as history of actors in the system, to better protect consumer rights policies at the point of transaction. Overall, more and better communication channels challenge the existence of bad actors.

New Market Entrants – Fostering Financial Inclusion

The barriers to entry of financial services are now lower than ever. New entrants have an incentive to foster financial inclusion to grow the market, and thereby avoid competing with large incumbents. They can profitably serve previously under-served segments given their lower cost structures, greater customer reach, or superior ability to monitor or score risk. As a result, larger numbers of consumer and business segments can participate in the financial system in new and different ways. PayPal, an early pioneer of this, enabled person-to-person payments without bank intervention (at the transaction level) and offered electronic payment acceptance to merchants too small to qualify for merchant card acquiring accounts. Across the financial services sector, FinTech is promoting financial inclusion: crowd funding platforms extend credit to consumers and SMEs, robo-advisors (see Case study 3: Financial advice) increase the number of people that can get expert, actionable financial advice, and digital payments platforms allow the unbanked to conduct online financial transactions.

Another major benefit to digital financial inclusion is the ability to offer targeted and highly relevant financial information to consumers. In an offline market, consumers must seek to educate themselves via a complete programme of information. Online markets allow ‘push notifications’ that educate the

consumers in a way that is highly relevant to what they are doing, as well as providing supplementary information such as ratings, recommendations and additional information via social media.

Although FinTech opens the system up to new players, it also introduces new types of vulnerability. Highly questionable practices of short-term consumer lenders are one example, where poor consumer education and questionable customer acquisition tactics result in credit extended to unnecessarily high-risk consumers. Fraud and exploitation remain an ever-present threat, as some bad actors target poorly educated new consumers. However, fraud thrives in low-information environments and is less likely to succeed in the data-rich, hyper-connected digital world that forms the basis of financial services today.

Case study 3: Financial advice

Traditional advice giving by financial advisors is being replaced or augmented by 'robo-advisors' that do automated advice and automated asset allocation. With the traditional model of financial advice including minimum asset requirements and fees around 1% of assets under management, robo-advisors make financial advice automated, sound, cost-efficient (around a maximum fee of 0.5%), and within reach of people that fall below the traditional asset requirement levels.

Emerging Regulatory Challenges and Solutions

By nature, FinTech is designed to accomplish much of what regulators desire: it thrives on disintermediating low-value-add players, it fosters open communication, and it runs on a low-cost infrastructure and thereby minimises service delivery costs. It promotes transparency via social media and other platforms, and it seeks to grow the market by increasing the number of participants in the market, thereby supporting financial inclusion. Emerging challenges include how to create regulation for novel actors, new interactions, and unique business models in a rapidly changing environment. It will also require the foresight to incorporate the effects of not-yet-emergent technology. The system will continue to change rapidly and with new ways of doing things come new ways to potentially defraud the public or destabilise the system.

To support a vision of the financial services' future as more open, transparent, free and safe, regulators have a critical role (discussed further in Chapter 6). The challenge is to create a regulatory framework that is strong enough to promote systems safety, while flexible enough to foster innovation and growth. An innovative way to promote this could be creating areas of safe experimentation where ideas can be tested and new entrants can test business models in the system without the threat of destabilising the system, much like in medical trials. These experimental areas could have a flexible approach to regulation and a wait-and-see approach before adopting new regulatory models that apply to the rest of the system. In turn, this can help provide standards for the industry that promote safety as well as innovation. This could aid regulators in continuing to maintain a system that is flexible and sustainable enough to include the safe coexistence of large incumbents as well as smaller, niche entrants, whilst continuing collaborative knowledge sharing between regulators and existing and new market participants.

Table 1: Example FinTech emerging business models

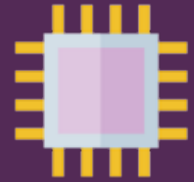
CATEGORY	SUBSECTOR	CURRENT MODEL	EMERGING MODEL	EXAMPLE
Banking	Retail	Debit card	E-wallet	PayPal
Banking	Retail	Current account	Direct bank	ING Direct
Banking	Retail	Education loan	Education crowd lending	Prodigy Finance
Banking	Retail	Personal loan	Crowd lending	Zopa
Banking	Corporate	Business loan	Crowd lending	Funding Circle
Banking	Corporate	Invoice factoring	Invoice trading	Platform Black
Banking	Alternative assets	Bonds	Bond platforms	UK Bond Network
Banking	Corporate	Property loan	Crowd lending	Proplend
Insurance	Personal	Questionnaire	Telematics	Automatic
Insurance	Personal	Legacy infrastructure	Software-as-a-service	Guidewire
Asset management	Financial advice	FA consultants	Robo-advisors	Betterment
Asset management	Brokerage	Broker	Online trading accounts	TD Ameritrade
Asset management	Brokerage	Broker	Trading social networks	eToro
Asset management	Alternative assets	Venture capital	Crowd investing	Crowdcube
Capital markets	Securities	Human traders	High-frequency or algorithmic trading	HRT Europe
Capital markets	Research	Financial market data terminals	Streaming data sites	LSE Real Time Data
Capital markets	Research	Research reports	Peer-to-peer information	Stocktwits
Capital markets	Currencies	Opaque pricing	Low-cost aggregators	Currency Cloud
Capital markets	Currencies	Sovereign currencies	Digital currencies	Bitcoin
Charity	Corporate and personal	Gifting	Rewards and donations platforms	CrowdShed



Professional services



Operations



Innovation



Development



Live hosting

Globalisation and UK FinTech

Over the past 200 years the UK has defined, shaped and now dominates the global financial industry. In an increasingly interconnected world, FinTech propositions have a particular potential to scale cross-border in distributed delivery models: a significant amount of this global activity could be centred in the UK and contribute enormously to UK employment and trade flows.

Chapter 5: Globalisation and UK FinTech

Summary

Over the past 200 years the UK has defined, shaped and now dominates the global financial industry,²⁸ from which it derives considerable benefit in terms of employment, tax revenues, international influence and economic security. The UK is uniquely well positioned to build on its financial, academic and entrepreneurial heritage to become the global hub for distributed FinTech businesses. In an increasingly interconnected world, FinTech propositions have a particular potential to scale cross-border in distributed delivery models: a significant amount of this global activity (innovation, product development, live hosting, operations, professional services) could be centred in the UK and contribute enormously to UK employment and trade flows. This chapter sets out the implications of attaining global FinTech hub status – the UK's strengths and natural advantages, the challenges and barriers, and the possible actions for success. For examples of the approaches used by other countries see Case studies 4 and 5 on Singapore and Estonia.

UK's Unique Potential to take a Global Lead in FinTech

The UK has significant competitive advantages in the field of FinTech that make it a natural candidate to take the global lead and to flourish. Compared to the world's other major centres of financial innovation, the UK enjoys a unique collocation of world-class financial services activity and technology innovation. This collocation of financial services and technology/innovation know-how gives the UK a particular advantage in wholesale and commercial banking innovation and regulatory innovation, which is less well explored globally than retail financial services where California start-ups excel. UK assets include:

- The world's greatest concentration of financial firms and professionals.
- A well-developed innovation culture and infrastructure.
- Excellent technical infrastructure.
- University computing and finance assets.
- A strong start-up culture.
- An optimal global time zone, business-friendly legislation and oversight, and excellent travel communications worldwide.

The realisation of this potential is the creation and development of world-beating UK-based FinTech companies. Technology leaders are exemplified by Alibaba/Alipay, PayPal, Google, Apple, Amazon and Facebook. These define new paradigms for commerce and financial services on a global scale.²⁹

Challenges and Barriers

Although the UK has many advantageous attributes they are not currently optimally coordinated and sponsored in a synchronised way. This may lead to lost economic opportunities and under-performance against current potential.

There are four particular areas for opportunity:

- The link between academia, investment and industry in the UK has in the past been weaker than other leading FinTech centres such as California. There, close collaboration between Silicon Valley, start-ups and world-class universities such as Berkeley and Stanford has spawned several global organisations which have reshaped worldwide consumer behaviour.
- There is no coordinated programme of attracting and retaining entrepreneurial FinTech start-ups in the UK. This is particularly important in FinTech because the nature of the industry makes it highly mobile.³⁰ Globalisation therefore makes the competition to attract and retain creative professionals and companies more intense.
- The considerable speed of FinTech innovation and development makes it difficult for regulators to keep pace with change and establish governance models that strike the right balance between systemic control and promoting continual reinvention and improvement.
- There is under-engagement between the UK FinTech industry and the international technology community, resulting in lost opportunities to take global leads and boost the UK's global presence in FinTech. This is in contrast to other sectors, such as medicine, where the UK is strong in international collaboration.

Case study 4: Financial Markets Development Department – Singapore

The Financial Markets Development Department aims to promote a vibrant financial market in Singapore, with a focus on developing the capital market, asset management and insurance sectors, and to foster a sound and innovative technology, payments and exchange infrastructure.

In particular, the Technology and Payments Division is responsible for identifying opportunities and steering industry- and nation-wide initiatives that streamline payment channels and harness technology for the financial sector. Efforts are focused on developing platforms, capabilities, tools and innovative solutions to grow Singapore's financial sector and to foster an environment for innovation to flourish.

Thong Leng Yeng and Roy Teo – Monetary Authority of Singapore

A Goal for UK FinTech: Global Leadership

Creating a global FinTech hub in the UK will require a clear articulation of what this means and what needs to be overcome to establish this position. The UK could actively promote the development of a global FinTech innovation community, establishing the UK at its centre. This could attract innovators, retain them, lead in the creation of new sustainable financial services models and promote UK solutions and innovations in finance worldwide. To achieve this, there are key areas for development.

Case study 5: Estonia's digital identity

Estonia: a densely forested country of 1.3m people in the north-east corner of Europe, just south of Finland, just east of Russia. Not where you might expect 99.8% of banking transactions to be done online, tech start-ups and angel investment per capita to be the highest in Europe, and digital public services to be the global gold standard. Widely considered to be among the world's most vibrant digital economies, entrepreneurship is endemic in Estonia, energised by forward-thinking, liberal policies and an exceptionally IT literate and highly educated society. A great enabler of advancement in the IT sector has been digital identity, together with a willingness to accept digital by default.

The e-Estonia Story – e-ID

Few would contest that the advances of the last 20 years have been driven by government design. In the mid-90s, Estonian leaders consciously identified an e-society as a way to expedite economic growth and improve human capital through investment in IT infrastructure and education. Their grand vision was an open framework of public databases that could be utilised by the private sector, for the benefit of citizens and businesses alike. Estonia recognised that significant amounts of time and money would be saved through the provision of unique digital identities. For businesses and public bodies, this would significantly reduce customer-facing and back office costs. For end users, it would offer greater convenience and privacy. In 2002, each citizen was given an ID card and PIN codes. By 2005, they could use these to sign documents digitally, use internet banking, incorporate a company, file annual tax returns, register store rewards, vote, and access over 300 public services. In 2007, executing the most regular of these tasks also became possible by phone following the introduction of Mobile-ID.

Trust and Functionality

Crucial to the uptake of e-ID was ensuring that the system was secure and easy to use. The two-factor authentication of e-ID was a welcome safeguard. Security was further enhanced by X-Road – a network which pulls together personal data from numerous decentralised databases only upon an authenticated request. These requests can also be monitored so users know what, when and why their data has been looked at. The combination of security and transparency has built a strong basis of trust among users of Estonian digital services. Over 99% of Estonia's banking transactions now utilise the X-Road spine to authenticate users. Estonia has also sought to avoid doing too much with a single system; processes remain distinct to fulfil one core task. This uncomplicated approach means from login to completion, signing a document digitally takes on average 30 seconds; your tax return 5 minutes; incorporating a company 15 minutes.

Furthermore, the 'once only' principle adhered to means users never input the same data twice. With this digital identification system being deemed trustworthy and functional, its use has taken off. For example, the total number of digital signatures grew from 100m in January 2013 to 200m in February 2015. That equates to 39 signatures per capita per year and rising. Digital signatures are legally binding, and are now available to UK companies through Estonian e-residency. Because this digital identity system remains open, there is no limit

to the public or private services which can be integrated in the future.

Summary

The Estonian example underlines three core principles which can advance use of digital financial services and the wider digital economy – identity, trust and functionality. The UK should take note and capitalise on the efficiencies digital identity creates. Europe will hopefully soon catch up – it was no coincidence that Andrus Ansip, the Estonian PM from 2005 to 2014, was chosen to lead the mission to create an EU Digital Single Market.

Chris Holtby and Alastair Brockbank – British Embassy Tallinn, Estonia

Building the International Network and the UK FinTech Reputation

- Recent work by UKTI to help entrepreneurs establish tech businesses in Singapore is a good example of intra-hub cooperation and engagement which shows that global guidance from a London base is possible. Therefore continuing to foster links and promote the exchange of ideas with the best innovation centres worldwide (Singapore, Mumbai, San Francisco, Seattle, etc.) is beneficial and ideal and something which UKTI is currently doing well.
- The UK could establish special conditions with other world innovation centres that promote rapid international expansion of emerging companies (e.g. start-up in UK, link to Singapore provides faster expansion into Asia – or vice versa), and jointly develop new standards and goals as well as collaborating on regulatory issues that affect everyone in a global economy.
- The UK might consider the establishment of a UK-led independent league table for innovation centres, akin to Global University League Tables. This could promote the UK global advantage and maintain attention on improving UK FinTech credentials. This has potential to provide two important benefits: (i) UK FinTech ideas and the UK FinTech approach can become global standards and concepts which establish leadership, (ii) good access to external thinking and diverse approaches around the world will keep UK FinTech thinking fresh, current and grounded.
- Globally connected financial innovation creates the ability to maintain a leadership position in corporate and institutional banking, and financial regulation, including the FCA and Financial Stability Board (FSB). Strong engagement with global bodies could help UK-based regulatory innovation in key frontiers such as financial inclusion and distributed ledgers. UK support and engagement with organisations such as The Gates Foundation, which is active in helping to establish digital financial services across Africa for unbanked communities, is encouraged.
- Government challenges can give direction to innovation, such as the UK Government's Longitude Prize. One way to channel this direction and involve the FinTech innovation community is to challenge creative start-ups to solve world problems. UK-located FinTech companies can solve global problems for UK corporates and champion global innovation based in the UK because

of the very high number of global companies that are either headquartered or have a presence there. The leading-edge mobile payments platform M-Pesa in Kenya, which has revolutionised the payments structure there and invigorated the Kenyan economy, was started in a Cambridge innovation lab. With a large number of foreign innovators and professionals in the UK, UK-developed ideas stand a greater chance of worldwide adoption than ideas developed elsewhere.

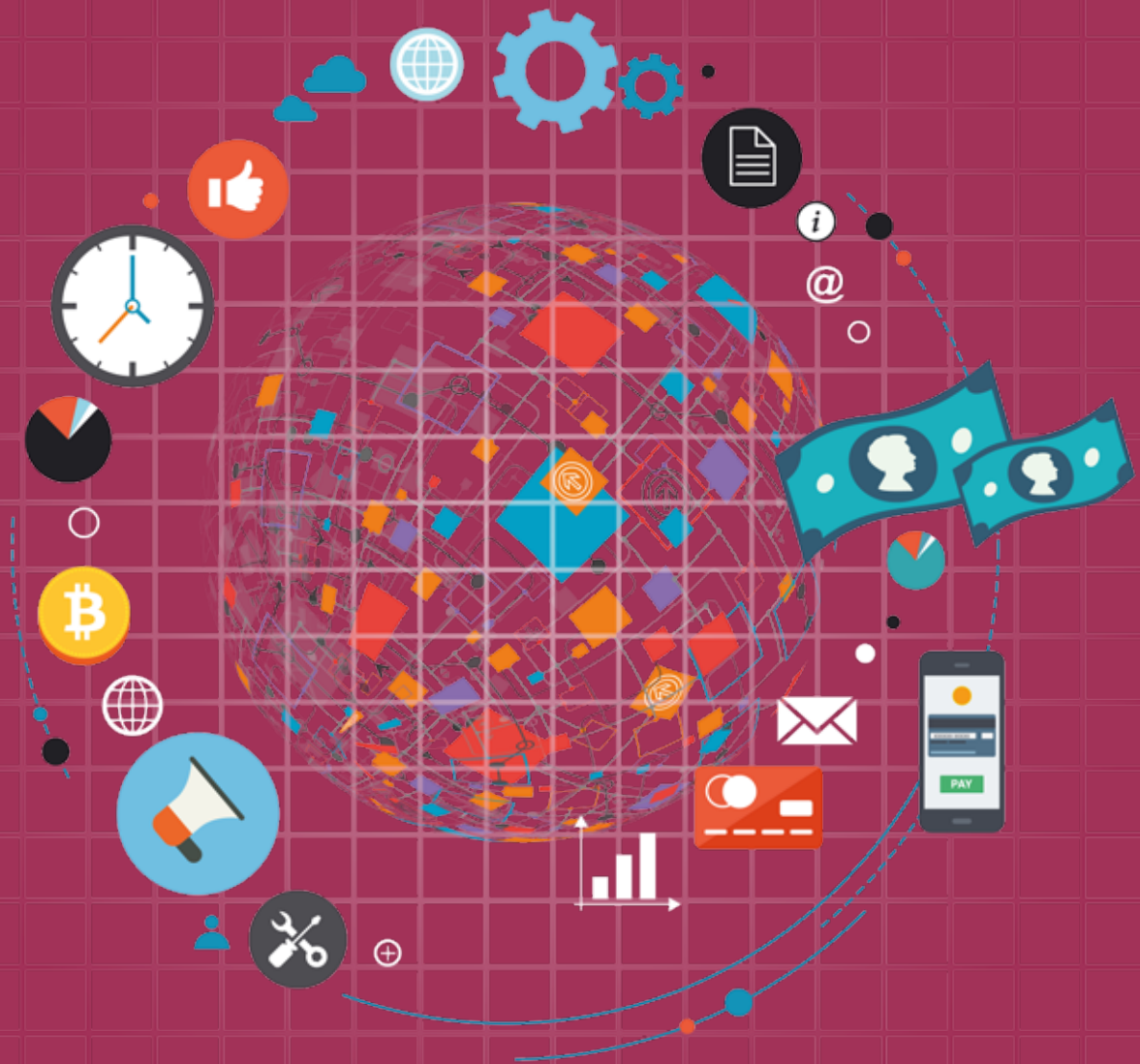
Securing Leadership Position/Preferred Hub Status

- Because of its location, the UK can benefit from easy access to different outlooks to financial technology and solutions. This can drive UK thinking and enable new concepts to be tested for international impact more easily. Examples include Vodafone's engagement with M-Pesa, Barclays' engagement with M-Pesa wallet sending and HSBC's support of globalising SWIFT access for non-financial institutions.
- The UK could look to Estonia for best practice mechanisms in retaining businesses. How to best promote UK credentials internationally. How to provide better access to UK and external investment for entrepreneurs who start up in the UK, and understanding what start-ups need to remain in the UK and delivering these environments.
- The UK could focus on fine tuning regulation and efficiency to make it consistently more attractive for businesses worldwide to invest and run their globally distributed business from the UK. It could promote these capabilities internationally to attract FinTech business activity to the UK.

Risks of 'Do Nothing' on UK Global Potential

The impact of not grasping this opportunity is a slow decline in the relevance and dominance of the UK financial sector in the global arena, with consequential impact to the UK economy. Crucially, these effects will play out slowly and will be difficult to address once they are apparent and visible.

- Near term: innovation activity will leak to or remain in non-UK locations, in particular the Far East centres of innovation. This will sap UK innovation activity with some limited impact to overall UK financial services. Some relocation of HQs for financial technology firms to more dynamic FinTech locations, and the start of net intellectual movement overseas for financial services.
- Mid-term: new disruptive services will be created by FinTech communities outside of the UK that apply to the UK, challenging traditional services offered by UK-based financial firms. Networks of global innovation centres will emerge without the UK. Major alternative financial providers will have no UK affinity or ties.
- Long term: financial activity drifts from the UK to other centres worldwide. Thought leadership in new financial services models is lost to competitor locations. This would ultimately lead to the UK-based financial sector contracting.



RegTech: The Future of Financial Regulation

How regulation might be applied to financial technologies and how these technologies might be applied to regulation lead to RegTech. This could provide a new generation of tools to assist in the regulatory process, allowing use of the massive amounts of digital data.

Chapter 6: RegTech: The Future of Financial Regulation

Summary

Effective financial regulation is crucial to the future success of the UK financial services industry and FinTech. In response to the rapidly changing financial landscape the FCA set up Project Innovate³¹ and so regulators are working to keep up with new business models entering the financial system. FinTech represents a challenge to regulators because it can often be outside of regulatory restrictions, such as with P2PL that has no central intermediary. This challenge, however, also represents a significant commercial opportunity, particularly to apply FinTech and big data paradigms to regulation, risk and compliance. 'Big data' regulatory online reporting and analytics, among other technologies, could create a new generation of UK regulatory technology (RegTech)³² that could contribute to financial regulation. Regulatory technologies encompass any technological innovation that can be applied to or used in regulation, typically to improve efficiency and transparency.

This chapter will look at the challenges that FinTech poses to regulators but will also discuss the benefits that RegTech could provide regulators, in both domestic and international regulation. Individually UK regulators, financial institutions, FinTech companies, training companies and universities are world-class; the challenge is getting them all to work together for continued regulatory excellence.

RegTech Vision

With the rapid rise of FinTech and new online technologies, EU/UK regulation could benefit from being structured to respond dynamically to the rapidly changing international financial landscape.³³ Regulators, including the European Banking Authority (EBA), Prudential Regulation Authority (PRA) and the FCA, could establish a new relationship with financial services and FinTech companies with the aim of open dialogue between regulators on regulatory aims and companies on observing regulatory requirements. This could probably involve the better use of technology to support people processes including real-time transaction analysis, online registration, standard data formats, standard (risk-weighted) asset indices, automated reporting, open-source compliance systems, and big data analytics.

This is an opportunity for the UK, but it is important to factor in the role of EU legislation. Much of the data now required, and the templates and means for its transmission, are mandated in EU law. This means that an agenda for RegTech-inspired regulatory reform would benefit from EU and international level considerations. Data has also taken on significance as a regulatory tool and requests for data are likely to expand and embrace FinTech if it is simplifying data processes.

Challenges

Financial regulation is thought of as increasingly complex and intrusive, with all significant financial institutions facing multiple regulatory jurisdictions, and regulators requesting increasing amounts of granular data from firms to ensure compliance. These data will, ultimately, allow the understanding of systemic risks, also enabling better understanding of the behaviour of actors in the system – consumers, banks, intermediaries, and to get a view of best practices. It will also enable understanding of how entities in financial systems are exposed directly and indirectly to one another via similar exogenous factors and directly via financial instruments referencing those same institutions. Moreover, the data should allow analysis of the degrees to which institutions react to regulation and how these reactions propagate through financial markets.

The complexity of regulation however may come at a price. Financial institutions have stringent and detailed requirements that potentially discourage innovation in new financial products. Thus, complexity and stringency in financial regulation raises an important consideration in the continuing support for new UK FinTech – the challenge of balancing encouragement with regulation. Likewise if the current trend in financial regulation continues, non-bank entities will emerge to do things that banks cannot or choose not to do, as discussed further in Chapter 6.

UK financial regulation could benefit from automated reporting and advanced analytics being applied to compliance and risk measurement. At a time when institutions are asked to provide unprecedented quantities of data, there remains doubt about the regulators' ability to measure risk and use such risk measurements in determining prudential regulatory regimes. This doubt is understandable, as much of recent prudential regulation has been designed and implemented in a constrained period of time, yet addresses complicated and evolving problems such as systemic risk measurement.

FinTech and Big Data Applied to Regulation

Online, FinTech and big data 'revolutions' thus far have had minimal impact on regulation, risk and compliance. Many organisations consider big data as collecting comprehensive data on 'customers' and applying analytics. However it is also about 'data-driven' companies; reorganising the company to capture increasing amounts of data and using this to develop new products and services and provide improved services. Amazon.com, Amazon Kindle and especially the Amazon Fire phone are classic commercial examples of this. With regard to regulation, big data initiatives might range from the academic community supporting BoE research or analysing the PRA and FCA's data, attempting to automate UK financial regulation and compliance.

The development of quantitative regulatory approaches can be complicated by the possible conflicting objectives of regulators and institutions. One clear example is the use of internal statistical models and data to derive inputs to the risk-weighted assets formulas – an area that would enormously benefit from independent quantitative research. Similarly, the practical assessment and management of financial systemic risk is naturally multidisciplinary, but in essence must 'work back from the data' and account for the likely actions and reactions of market participants. Thus there is a potential new area of research, in which regulatory mechanisms can be designed cognisant of agent decision

making, and risk can be evidenced by data that is describing institutions' assets and liabilities and other exposures. The skills required for such an agenda are to be found in part among computer and data scientists.

Data-Driven Regulation and Compliance

There is the possibility that financial regulation and requests for increasing amounts of data are hindering the capacity of traditional financial institutions to operate and more importantly innovate. Regulation and data requirements could benefit from being redesigned, simplified and automated. Harmonising financial regulation across multiple jurisdictions and creating new automated reporting and analytics standards could improve the financial services industry's efficiency, potentially reducing systemic risk and delivering economic benefits. This could be achieved through:

- Regulatory policy modelling – emerging techniques such as agent-based modelling could be used to simulate the likely impact of new policies before legislation (e.g. MiFID II, EU FFT) and the practical impact of existing regulation, including conflicts between regulators.
- Reporting standards – developing common compliance tagging and reporting standards across multiple jurisdictions could support calls for the mandatory sharing of information between regulators with overlapping jurisdictions.
- Systemic risk tools – if the UK academic community were encouraged to investigate a range of mathematical techniques for risk, this has potential to yield important tools for regulators.
- Harmonisation – the integration of national, European and global financial monitoring systems could be beneficial. With multiple jurisdictions institutions are faced with varied regulatory demands. For example one European bank is said to have individual 'supervisors'. Standardised and harmonised reporting could therefore be beneficial for both institutions and regulators.
- Uniform compliance tools – because compliance is becoming increasingly analytical, the regulators might encourage the development of a suite of open-source compliance tools. This would in itself be an opportunity for the emerging FinTech community.
- Collaborations and selected data sharing – could be encouraged between different international regulators, e.g. on 'bad actors' within the system. For instance, it would be beneficial for the UK to know which UK banks are being investigated for bad practices in other markets.
- Regulators collaborate with FinTech – to see what kinds of data are being collected and new ways of collecting data, e.g. logging location data alongside transaction data.

Regulatory Infrastructure

The regulators could benefit from a fully integrated analytics infrastructure able to handle an increasing range of financial, economic, retail, spatial, text and social data. As well as historical and streamed data, this could include public sentiment monitoring and sophisticated analytics techniques such as machine learning. The infrastructure to support both the automated collection of data and analysis presents a commercial opportunity for UK RegTech companies using innovative technologies:

- Database and streamed processing infrastructure – there are a number of novel technologies available for real-time processing, ‘big data’ storage and integration of heterogeneous and textual data (e.g. Hadoop, KDB, MongoDB, Cassandra). Such technologies are particularly suitable for large-scale data organisation and business analytics needed by the regulators. A comprehensive study is needed to identify the appropriate technologies to support the regulators.
- Data mining analytics tools – there are an increasing range of machine learning, computational statistics, complexity and statistical physics algorithms (such as Deep Learning) that offer the potential of powerful data mining and simulation techniques for enhanced decision taking.
- Visualisation tools – due to the complexity and quantity of data involved in big data analytics the regulators require powerful tools for the visualisation, understanding and reporting of data to colleagues.
- Computational platform – a key to online reporting and unlocking ‘big data’ financial analytics is to provide regulatory professionals with computational platforms (including advanced visualisation tools) that allow them to analyse multiple heterogeneous data sources without the need for extensive expertise in programming.

Training and Education

There are already skills shortages with regard to regulatory and compliance staff, particularly software, analytics and regulatory/compliance ‘talent’. The qualitative shortages will become worse as processes are automated and both regulation and compliance becomes increasingly analytical with the rise of what might be termed quantitative regulation. Given the UK’s (and London’s) reputation there are training and educational opportunities:

- Regulator-recognised qualifications – the FCA could take the lead in encouraging and possibly certifying continuous professional development (CPD) courses in regulation, compliance and associated analytics.
- Commercial training courses – commercial CPD providers could be encouraged.
- University programmes – new Masters level qualifications in Financial Regulation targeted at professionals in financial regulation and compliance both in supervisory bodies and in financial institutions. This would include aspects of both quantitative analysis and ethics.

The requirement would be the delivery of industry-leading education in a broad range of areas including UK financial market regulation, quantitative risk management, systemic risk and financial stability, compliance, market abuse, data protection, anti-money laundering, data analytics, FinTech regulation and the role of quantitative analysis, introduction to financial markets and financial markets operations, financial markets analysis, financial markets trading strategies and systems, and algorithmic trading.

University Engagement

The Research Councils and the financial services industry have identified academic research applied to regulatory data, risk and compliance as offering significant opportunities both for UK science and for UK regulation. The Engineering and Physical Sciences Research Council (EPSRC) and the Economic and Social Research Council (ESRC) could therefore be encouraged to establish regulator-led coordinated research programmes. UK academics may provide major research contributions and training for new software and analytics professionals in regulation, risk and compliance. To conduct world-class financial research and training, UK academics may require access to ‘real-world’ data (e.g. regulatory data, financial market data and economic data).

Equally important is a secure national data and analytics facility to support the UK academic community, as well as FinTech start-ups. This could include access to real-world financial and regulatory data, both real-time and historic, and analytics, providing access to a computational environment to support big data analytics. This is research that typically goes beyond standard data mining, such as computer simulation modelling to handle complex low-level data retrieval and data streaming, simplify simulation development, execution, monitoring and reporting.

When considering access to sensitive and proprietary regulatory and financial data it is important to distinguish ‘contributors’, such as regulators, banks and data providers, from ‘consumers’ which include academics and SMEs. Data will clearly need to be anonymised and secure; but equally important, banks and data providers may be concerned about contributing data that could be freely available to commercial organisations. Hence it may be necessary for ‘consumers’ to be authorised and controlled.

FinTech/RegTech Training Academy

Given the escalating demand for regulation/compliance professionals and data scientists, plus the training needs of market participants and FinTech companies, Government could consider a programme to encourage (and certify) commercial training providers and also encourage university postgraduate modules or programmes.

Financial Data Research Facility

To support academic research, three classes of financial data are required: commercial data, public domain data, and proprietary industry data sets:

- A UK WRDS³⁴ – commercial data could be provided by a secure centralised UK data facility comprising commercial data from key data providers (Thomson Reuters, Bloomberg, Markit).
- Public domain data sets – this comprises publicly accessible data (e.g. social media, economic) and contributed anonymised data.
- Proprietary data sets – most important is highly secure access to sensitive data sets and streamed real-time data owned by UK regulatory and industry partners; initially on-site.

The Alan Turing Institute might offer a solution akin to the US Office for Financial Research (OFR).

Bringing Regulators, Businesses and Academia Together

Individually UK regulators, financial institutions, FinTech companies, training companies and universities are world-class. The challenge is in getting them all to work together to produce a highly automated and effective ‘data-driven’ regulatory system. In fostering close collaboration between regulators, institutions and FinTech companies, much might be learnt from clinical trials (i.e. Phase III) structures.³⁵ Specifically, regulator monitored ‘sandboxes’ for innovators to experiment with virtual environments or real people. Grand challenges are also catalysts to stimulate collaboration and knowledge exchange:

- Open-source compliance system – open-source software is a popular vehicle for supporting innovation. One possible challenge that could be beneficial for the FinTech community would be an automated registration and open-source compliance reporting system supported or certified by the FCA that would speed up registration and reporting for new start-ups in financial services.
- Financial ‘weather forecasting’ system – another suggestion is the development (for the BoE/PRA) of a national financial monitoring system for forecasting systemic risk in the UK banking system. The feasibility of such a system has been shown, albeit on a small scale, by the Bank of Mexico, which does the clearing for Mexican financial institutions, and has developed a system for monitoring systemic risk based on principal components analysis (PCA).

A UK project could be a vehicle for bringing together regulators, key financial institutions, FinTech companies and the large number of world-class UK academics working on risk, software engineering and high-performance computing (HPC). Such a project may take years and may not succeed, however the spin-off in risk, analytics and software research results are likely to be significant.

UK RegTech Sector – Going Forward

Online, FinTech and big data applied to regulation, risk and compliance represent a significant commercial opportunity. Just as the UK and London benefit from ‘marketing’ its innovative FinTech companies, it could benefit from building a RegTech community, integrating regulators, FinTech start-ups, education and training providers, and academia. In conclusion, to track rapid changes in the financial landscape, regulatory/supervisory bodies could leverage online reporting and big data analytics to build systems that will enable them to carry out their increasing mandates, and allow the practical reality of rolling out various approaches to macro-prudential regulation that have been researched over the years. There is no technological barrier to most of these aspirations – computing power, storage technologies, data/analytic capabilities, all represent ‘art of the possible’ technologies today. The added benefit is an opportunity to modernise the infrastructure, automate reporting and encourage the data reporters (banks, etc.) to modernise their own systems and market infrastructure. This could add significant economic value by reducing costs, improving transparency and trust, and allow positive new business models. Under this scenario FinTech and RegTech can really flourish as there will be consistency, ‘platforms’ and data to work with.



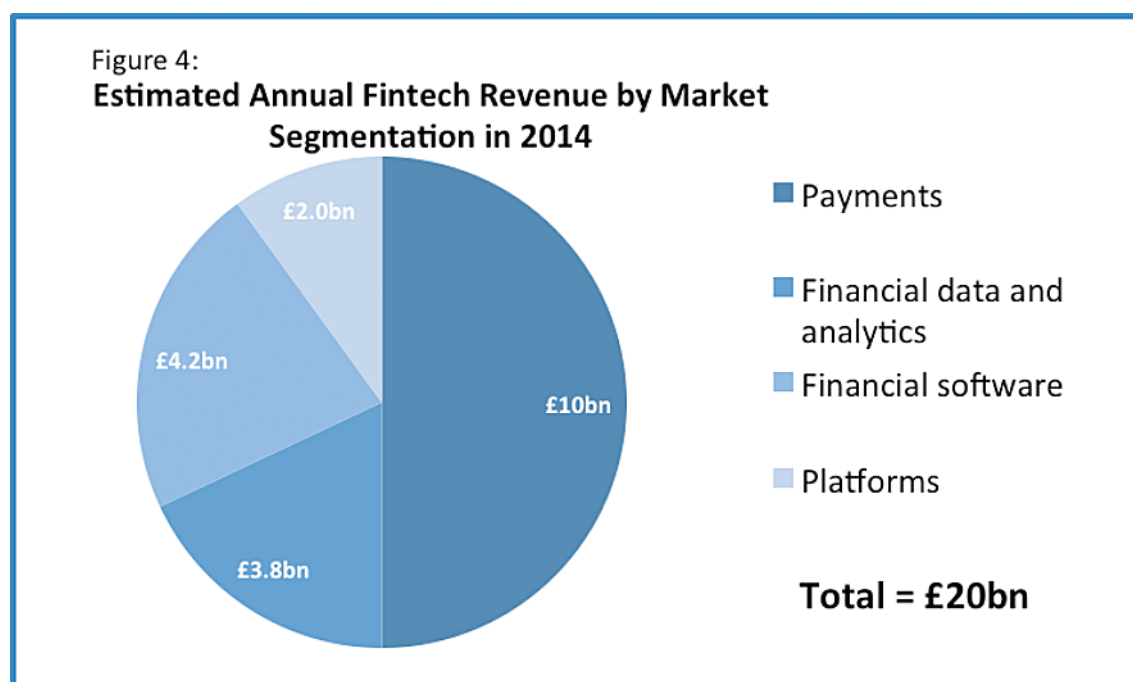
Appendix: The Economic Impact of FinTech

It is impossible to entirely predict the impact that FinTech may have on the future UK economy. The purpose of providing an educated outlook, however, is to gain a measured view of what success might look like. The UK is a highly regarded FinTech hub, with an estimated current market value of £20bn. Continued effort to cement this position has the potential to contribute enormously to the UK economy.

Appendix: The Economic Impact of FinTech

Summary

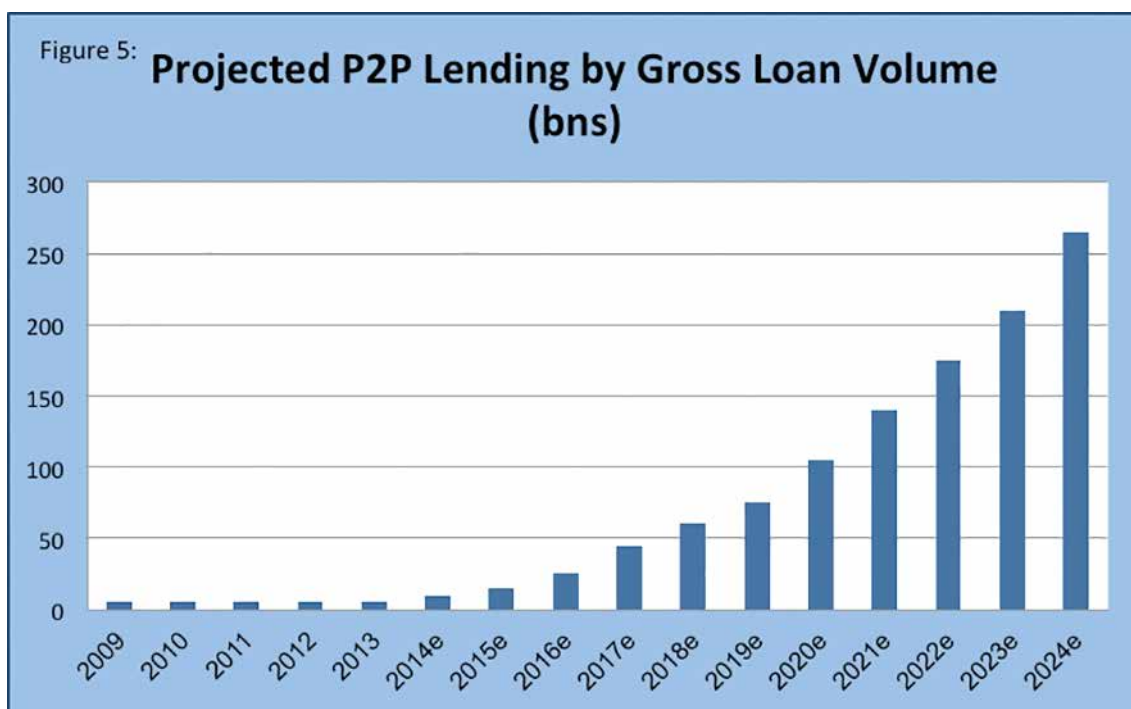
The ever evolving nature of disruptive and emerging technologies means it is impossible to wholly predict the future economic benefits of financial technologies (FinTech). It is currently estimated to generate £20bn in annual revenue in the UK.³⁶ Both the financial services and technology sectors contribute significantly to the UK economy. Financial services paid £65bn in tax in 2012/13³⁷ and account for roughly 9.4% of gross domestic product (GDP) (14.5% including related services such as legal and consultancy³⁸). The UK has the largest financial services sector in the world.³⁹ Similarly the UK's prominent technology sector contributes enormously to GDP, the internet industry alone accounting for roughly 8.4%.⁴⁰ Technology and financial services are interrelated, banking and securities institutions spending \$485bn (£319bn) on IT in 2014.⁴¹ Strength in both these areas may help to build a sector which broadly encompasses both financial services and technology, although these individual strengths may not guarantee success in FinTech.



Source: UKTI and EY (2014) *Landscaping UK Fintech*. Available at: [http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/\\$FILE/EY-Landscaping-UK-Fintech.pdf](http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/$FILE/EY-Landscaping-UK-Fintech.pdf) (accessed 11 March 2015).

FinTech is an industry in its own right with its own unique set of challenges. It also has the potential to harm the existing financial services sector and blend with other sectors, making it difficult to isolate the financial services element. It is important to recognise that FinTech can both contribute to and disrupt (positively or negatively) many industries that might integrate FinTech into their offerings, e.g. automotive/telematics, media/micro-payments, healthcare/insurance, real estate/mortgage investing.

FinTech plays a role in the UK economy already and this will probably increase given current and past growth rates and if the UK continues to develop its already successful FinTech offering. The purpose of considering the economic potential of FinTech, as well as the associated economic risk of ‘doing nothing’, is to gain a measured view of what success might look like. This includes job creation, investment in UK FinTech businesses, and use of FinTech by both businesses and consumers, all of which could contribute significantly to the UK economy.



Source: Liberum (2014) *P2P Lending: Opportunity & how to invest*. Available at <http://www.lendacademy.com/wp-content/uploads/2014/03/Liberum-AltFi-Pres-11th-Mar-14.pdf> (accessed 12 March 2015).

Business and Investment

FinTech services span many financial sub-sectors, including banking, insurance, asset management and trading. FinTech products include digital currencies and mobile payment apps and alternative finance models such as P2PL and invoice trading.

Case study 6: GLI Finance

- Investment company
- Portfolio of 16 alternative finance providers
- £250m lent in the last two years
- £158m in 2014 alone
- Funding focused on SMEs

Disintermediation from traditional banking systems is one area which may see significant growth in the UK. The UK alternative finance market was estimated to be worth £1.74bn in 2014. This was an increase of 161% on the previous year, and is projected to grow to around £4.4bn in 2015.⁴² Many alternative finance options are FinTech offerings. For instance of the £1.74bn, £749m was peer-to-peer business lending, £547m peer-to-peer consumer lending, £112m crowd funding and £270m invoice trading.⁴³ Currently 90% of business loans in the UK are provided by the big four banks⁴⁴ yet there is an estimated finance gap of between £84bn and £191bn in the next five years given demand.⁴⁵ This indicates a huge potential for UK businesses to use other financial operators and services. Even those already accessing traditional bank loans may be tempted by options that potentially provide more flexibility, i.e. invoice trading. Nesta report that the estimated proportion of UK SMEs currently using alternative finance is only 2.4%, although 86% say they are likely or very likely to use alternative finance in the future, which will include FinTech.⁴⁶ Alternative finance, including FinTech finance models, is therefore well placed to fill the funding gap and drive the use of non-bank finance.

Case study 7: Accenture FinTech Lab

- Initiative to support and advise FinTech businesses and entrepreneurs
- First lab started in New York 2010: since then has 18 alumni companies, 150 new jobs, \$47m (£37m) new investment
- London lab modelled on New York, 9 months after participation companies experience: revenue increases of 140%, staff increase of 40%, \$10m (£6.5m) new investment

It is important that structural support is available for FinTech start-ups and SMEs as financial services businesses have much higher than average business failure rates in their first year (14% versus 7% respectively);⁴⁷ emphasising the need for support. FinTech businesses and entrepreneurs that are advised and supported by FinTech specialist organisations generally have good outcomes⁴⁸ (see Case study 7: Accenture FinTech Lab).

Non-FinTech SMEs could benefit from an awareness of both traditional and FinTech finance options available to them in order to get the best deals. Nesta report that 44% of SMEs were aware of alternative finance (including non-FinTech alternative finance) but only 9% had used it. As SMEs contribute almost half of UK GDP and represent 99.9% of businesses,⁴⁹ it is important that both FinTech and non-FinTech SMEs are supported. FinTech and other alternative finance platforms could help non-FinTech SMEs grow by gaining access to finances that may not have been offered previously. This could also enable the growth of FinTech SMEs that provide such offerings.

Inward investment for FinTech businesses in the UK could encourage further growth. Estimates of the investment in FinTech in the UK vary from \$3bn (£1.97bn) in 2012,⁵⁰ \$590m (£388m) since 2011 to UK and Irish FinTech companies⁵¹ or \$2.97bn (£1.95bn) invested in 2013 alone.⁵² Despite differing estimates it is clear that investment in FinTech businesses in the UK is improving

despite first round funding being difficult to obtain (and subsequent rounds even harder)⁵³ and according to the FinTech 50 the UK is attracting high-quality investments which contribute to economic growth;⁵⁴ 25% of global FinTech FDI projects in the last half decade were in Europe, nearly half of which were in London.⁵⁵ The positive economic impact of FinTech is reliant on continued investment, which rests upon efficient and open capital and money markets and attractiveness of the UK market.⁵⁶ These challenges are addressed in greater detail in this report, although as the figures would suggest, recommendations that are likely to increase the desire for businesses to stay and grow will better assist in positive economic growth.

Jobs, Skills and Services

The UK has 2.4 million people working in high-tech industries, 825,000 of which are STEM roles,⁵⁷ whilst 135,000 UK wide work in financial services technology.⁵⁸ Whilst the UK has a large pool of talent from which to gain and retrain into FinTech businesses, 45% of technology business leaders in 2013 reported a skill shortage as a big challenge.⁵⁹ Although the skills shortage is a challenge it could also be viewed as an opportunity. The UK could attract, train and nurture new talent to fill the gap, and drive job creation in new and emerging sectors, utilising already existing talent. An existing talent pool and a commitment to growing talent could contribute to attracting businesses into the UK by giving them access to this highly skilled workforce.

Case study 8: Zopa

- P2PL platform
- Over £750m lent to borrowers since 2005
- £275m of this was in the last 12 months

Job displacement also poses potential significant disruption with the advent of FinTech. Many jobs may become automated, such as banking staff being replaced by digital banking technology.⁶⁰ A flexible approach to this skills gap, particularly in retraining for a digitally skilled workforce, could lessen the threat of any potential displacement.

The skills gap is also significant to the knowledge and use of FinTech products and services. Consumer spend will naturally contribute to economic growth but is subject to restricted knowledge and usage. FinTech companies which are well known typically perform well (see case studies 8 and 9⁶¹). The UK has a huge digitally active customer base with the potential to use FinTech services. In 2014 91% of adults had broadband internet access and 58% of adults had access to the internet via a mobile phone.⁶² However, alternative finance, a large part of the current FinTech market, has low awareness and usage rates. Nesta reported that 58% of consumers were aware of alternative finance although only 14% had used it.⁶³ UK market dynamics such as the economic downturn coupled with consumer sentiment have left consumers more open to new business models, and levels of confidence in banks in the UK in 2013 was estimated as low as 23%.⁶⁴ Lack of awareness and usage coupled with high digital access and consumer openness could therefore be an opportunity to encourage FinTech

use, simultaneously educating and adding economic value through consumer spend.⁶⁵

FinTech of course presents challenges as well as opportunities, both of which are addressed in this review along with the risks. A large risk when contemplating the UK economy as a whole however is doing nothing. In this scenario not only does the UK stand to lose the economic potential of FinTech but simultaneously puts financial services and technology sectors at risk as a result of not being at the forefront of financial technology in an ever advancing technological world.

Conclusion

The economic strengths of the UK, including a world-class financial centre, an ever-growing technology hub, global links, attractive regulatory environment and a highly skilled workforce are all contributing factors in defining London as a highly sought-after world-class FinTech hub.⁶⁶ However, this review outlines a number of things that can be done to cement and strengthen this position, utilising existing capabilities with a view to enhancing FinTech growth, including but not limited to, closing the skills gap, continuing to encourage an amenable regulatory environment, and encouraging SMEs not just to start but to stay and grow.

Case study 9: TransferWise

Money transfer service TransferWise has saved SMEs and individuals over £3bn in international money transfers by giving people access to mid-market exchange rates – rates of 0.5% as opposed to the usual 5% charged by banks, and revenue has grown by 15–20% a month in the last 2½ years.

In addition to looking at how to strengthen the UK's role as a global FinTech hub, there is an opportunity to create best-in-class standards, practices, resources, regulation and technology in order to play a leading role in global development of FinTech. This would be important not just for the UK economy, but also for the ability of UK regulators and companies to be seen as world-leading and able to influence global standards and practices.

Although future predictions are of course vulnerable to uncertainties, an educated and informed vision of what the future may look like is possible. Therefore, given the current UK strengths in financial services and technology, the current contribution of FinTech to the economy, and the opportunities that current usage and awareness present, it is entirely possible to imagine a future in which FinTech contributes enormously to the UK economy as an intrinsic aspect of financial services.

Glossary

Alan Turing Institute – a new world-class research institute specialising in data science headed by Cambridge, Edinburgh, Oxford, Warwick and UCL universities.

Apple Pay – a mobile payment and digital wallet service by Apple that lets users make payments with some models of iPhone, Apple Watch devices and iPad.

Application programming interface – the programming that enables computer programs and software to directly communicate with one another.

Asset registries – a method used in accounting to track assets of an individual or organisation.

Big data – refers to both the information that companies hold, as well as the activity logs that take place on their systems.

Big data analytics – the analysis of big data (also includes solving problems associated with analysing the data, much of which can be unstructured).

Bitcoin – a type of digital currency which has no central clearings and is open platform.

Blockchain – a digital currencies database. Full blockchains, which are usually sequential, contain every transaction ever completed in the currency.

Challenge competitions – competitions in which participants are set a large challenge to be solved, i.e. a grand challenge is a type of challenge competition.

Clinical trials – trials run on human subjects, typically in four stages, to test the safety and efficacy of new medical interventions (medicines, devices, etc.) before they are taken to market.

The cloud/cloud computing – remote servers and software networks that allow centralised data storage and online access to computer services and resources.

Contactless payment systems – the use of radio-frequency identification for making secure payments, such as debit cards, key fobs and smart cards.

Cryptographic algorithms – mathematical sequences, processes or rules that encipher and decipher messages in a cryptographic system.

Data lakes – data storage systems that contain data stored in its 'native' format until it is required for use.

Digital currencies – currencies stored and transferred electronically (sometimes referred to as programmable money).

Disintermediation – the elimination of intermediaries as banks and brokers in financial transactions.

Distributed systems – a type of computer network that allows linked autonomous computers to share the resources of the system hardware, software and data.

E-wallet – an electronic device, such as a smartphone or computer, that allows individuals to make electronic transactions.

Financial exclusion – constrained access to mainstream financial services.

Financial inclusion – financial services at affordable costs for disadvantaged or low-income sections of society.

FinTech/financial technologies – used to describe ‘innovation in financial services’, covering new products from start-ups, or the adoption of new approaches by existing players where technology is the key enabler. It spans many industries including banking, insurance, asset management and trading.

Gamification – the application of gaming to non-game problems, such as business or social impact settings.

Google Wallet – a mobile payment system that allows its users to store debit cards, credit cards and loyalty cards, as well as redeeming sales promotions on their mobile phone.

Grand challenges – challenges set to promote solutions to global problems, including scientific, mathematical, and health and development.

Gross domestic product (GDP) – the monetary value of all goods and services produced within a country in a specific time period, usually calculated annually.

Haptic technologies – technology that uses the sense of touch to interface with the user, giving feedback.

Horizon scanning – the exploration of potential challenges, opportunities and likely future developments; can include topics such as ageing or climate change.

Incumbents – in business the term is used to denote the largest company or companies within a certain industry.

Innovate UK – an executive non-departmental public body, sponsored by the Department for Business, Innovation & Skills. It funds, supports and connects innovative businesses to accelerate sustainable economic growth.

Internet of Things – the sharing of data through everyday objects, for example, devices sending and receiving information about an individual’s environments and habits.

Invoice trading/invoice financing – the online auction of invoices, usually by SMEs to gain access to tied up cash, and increase their working capital.

Legacy systems – in computing, refers to outdated computer systems, programming languages or software.

Longitude Prize – a £10m prize challenge set by the UK Government to help solve the problem of global antibiotic resistance; based on the original Longitude Prize which was offered for finding a precise determination of a ship’s longitude.

Machine learning/cognitive computing – computer systems that can learn from algorithms as opposed to simply being programmed to do certain tasks.

Payday lending/payday loans – small, short-term unsecured loans.

Peer-to-peer lending (P2PL) – the lending of money to unrelated individuals, ‘peers’, outside of traditional financial intermediaries.

Principal components analysis (PCA) – a statistical procedure that uses an orthogonal transformation to convert possibly correlated variables into a set of linearly uncorrelated variables called principal components.

Project Innovate – a project run by the Financial Conduct Authority to help support industry innovation.

Push payments – the giving of money that has implied consent; this could be cash payment or credit transfer.

Quantum computing – study focused on developing computer technology based on the principles of quantum theory.

RegTech/regulatory technology – technologies that can be applied to or used in regulation, typically to improve efficiency and transparency in regulatory systems.

Research Council – a body that provides research funding, usually grants or scholarships.

Semantic Web – an extension of the current web, which aims to standardise the expression of relationships or meaning between web pages.

Social business – a business created and designed to address a social problem.

Structured databases – data that is fixed in terms of how it is stored, recorded, processed and accessed.

Supply chain finance (SCF) – optimising the flow of money in and out of a business across a supply chain or to its customers, sometimes through invoice selling.

United Kingdom Trade and Investment (UKTI) – a Government-based department which helps UK-based exporters succeed globally and assists overseas companies to bring high-quality investment to the UK.

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References

Vision

- 1 OpenFin (2014) Available at:<https://www.openfin.co/> (accessed 11 March 2015).
- 2 CryptoCoinsNews (2014) Top Bitcoin Companies Propose the Windhover Principles – A New Digital Framework for Digital Identity, Trust and Open Data. Available at: <https://www.cryptocoinsnews.com/top-bitcoin-companies-propose-windhover-principles-new-digital-framework-digital-identity-trust-open-data/> (accessed 11 March 2015).
- 3 The Financial Brand (2012) Differentiate Or Die: Boring Banks Need Brand Personalities. Available at: <http://thefinancialbrand.com/24268/differentiate-or-die-bank-brand-personality-attributes/> (accessed 11 March 2015).
- 4 Yorkshire Post (2014) Mass adoption of P2P lending could boost UK economy by £32bn. Available at: <http://www.yorkshirepost.co.uk/business/business-news/mass-adoption-of-p2p-lending-could-boost-uk-economy-by-32bn-1-6825389> (accessed 11 March 2015).
- 5 FCA (2014) Innovator businesses: Project Innovate. Available at: <http://www.fca.org.uk/firms/firm-types/project-innovate> (accessed 11 March 2015).
- 6 FCA (2014) Making innovation work for firms and consumers. Available at: <http://www.fca.org.uk/news/making-innovation-work> (accessed 11 March 2015).
- 7 KPMG (2014) Business impacts of cloud. Available at: <http://www.kpmg.com/au/en/topics/cloud/pages/default.aspx> (accessed 11 March 2015).
- 8 World Bank (2014) Global Financial Development Report. Available at: <http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTGLOBALFINREPORT/0,,contentMDK:23489619~pagePK:64168182~piPK:64168060~theSitePK:8816097,00.html> (accessed 11 March 2015).
- 9 The Guardian (2014) How to teach...financial literacy. Available at <http://www.theguardian.com/education/teacher-blog/2013/mar/04/financial-education-teaching-resources> (accessed 11 March 2015).

Work, People and Policy

- 10 Office for National Statistics (2014) Internet Access Quarterly Update, Q1 2014. <http://www.ons.gov.uk/ons/rel/rdit2/internet-access-quarterly-update/q1-2014/index.html> (last edition, updates discontinued) (accessed 11 March 2015).
- 11 [https://www.r3.org.uk/media/documents/policy/research_reports/personal_debt_snap/R3_Personal_Debt_Snapshot_\(9th\)_-_Payday_Loans_Nov_2012.pdf](https://www.r3.org.uk/media/documents/policy/research_reports/personal_debt_snap/R3_Personal_Debt_Snapshot_(9th)_-_Payday_Loans_Nov_2012.pdf) (accessed 11 March 2015).
- 12 See:<http://www.rand.org/labor/centres/financial-literacy/projects/decisionmaking-low-income-minority-2/video-games.html> and <http://www.edutopia.org/blog/games-to-teach-financial-literacy-andrew-miller> for a summary of some initiatives.
- 13 Source: Duncan A Smith, Centre for Advanced Spatial Analysis (CASA), UCL. Based on Census data.
- 14 Source: Duncan A Smith, Centre for Advanced Spatial Analysis (CASA), UCL. Based on Census data.
- 15 Baddeley, M., and Chen-Yu Chang (2015)*Collaborative Building Information Modelling (BIM): Insights from Behavioural Economics and Incentive Theory*. London: Royal Institution of Chartered Surveyors.
- 16 Bank of England (2014) The Economics of Digital Currencies. <http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2014/qb14q3digitalcurrenciesbitcoin2.pdf> (accessed 11 March 2015).
- 17 Bank of England (2015) One Bank Research Agenda. Available at: <http://www.bankofengland.co.uk/research/Documents/onebank/discussion.pdf> (accessed 11 March 2015).

Business Models

- 18 UKTI and EY (2014) Landscaping UK Fintech. Available at:[http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/\\$FILE/EY-Landscaping-UK-Fintech.pdf](http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/$FILE/EY-Landscaping-UK-Fintech.pdf) (accessed 11 March 2015).
- 19 Roemmele, B. (2014) What Is The Business Model Of Apple's iWallet? Available at: <http://www.forbes.com/sites/quora/2014/09/08/what-is-the-business-model-of-apples-iwallet/> (accessed 11 March 2015).
- 20 PwC (2011) The new digital tipping point. Available at:http://www.pwc.com/en_GX/gx/banking-capital-markets/publications/assets/pdf/pwc-new-digital-tipping-point.pdf (accessed 11 March 2015).
- 21 CMA (2014) Personal current accounts and small business banking not working well for customers. Available at <https://www.gov.uk/government/news/personal-current-accounts-and-small-business-banking-not-working-well-for-customers> (accessed 11 March 2015).
- 22 PwC (2011) The new digital tipping point. Available at: http://www.pwc.com/en_GX/gx/banking-capital-markets/publications/assets/pdf/pwc-new-digital-tipping-point.pdf (accessed 11 March 2015).
- 23 Confused.com. Telematics insurance could save you money. Available at:

- <http://www.confused.com/car-insurance/telematics> (accessed 11 March 2015).
- 24 Financial Times (2014) PayPal expands lending programme to merchants. Available at: <http://www.ft.com/cms/s/0/8c58d7be-838e-11e4-9a9a-00144feabdc0.html#axzz3U4JVIOQb> (accessed 11 March 2015).
 - 25 LCP (2013) LCP Netherlands Report Signals Greater Cost Transparency and Decreasing Pension Costs at Dutch Pension Funds. Available at: <http://www.lcp.uk.com/news--publications/news/2013/pa/lcp-netherlands-report-signals-greater-cost-transparency-and-decreasing-pension-costs-at-dutch-pension-funds/> (accessed 11 March 2015).
 - 26 New York Times (2014) Financial Advice For People who Aren't Rich. Available at: http://www.nytimes.com/2014/04/12/your-money/start-ups-offer-financial-advice-to-people-who-arent-rich.html?_r=0 (accessed 11 March 2015).
 - 27 Nesta (2014) Understanding Alternative Finance. The UK Alternative Finance Industry Report 2014. Available at: <http://www.nesta.org.uk/sites/default/files/understanding-alternative-finance-2014.pdf> (accessed 12 March 2015).

Globalisation and UK FinTech

- 28 Examples of UK lead and history: ICC and UCP rules, Lloyd's insurance market, joint stock companies and equity markets, international correspondent banking.
- 29 The suggested benchmark is market impact, not commercial scale. Successful organisations of the future may have smaller, more federal structures than the organisationally intact global firms that lead FinTech today.
- 30 Start-up entrepreneurs are usually internationally mobile, their investors are international, their products are virtual (data, logic) and not physical, successful start-ups are highly sought after by financial centres worldwide.

RegTech: The Future of Financial Regulation

- 31 Financial Conduct Authority, Project Innovate (www.fca.org.uk/firms/firm-types/project-innovate) and Feedback from consultations (www.fca.org.uk/static/documents/feedback-statements/fs-14-2.pdf).
- 32 Brummer, C. and Gorfine, D (2014) *FinTech: Building a 21st-Century Regulator's Toolkit*. Santa Monica, CA: Milken Institute.
- 33 PayPal. 21st Century Regulation putting innovation at the heart of payment regulation.
- 34 Wharton Research Data Services (WRDS), <http://wrds-web.wharton.upenn.edu/wrds/>
- 35 Phases of clinical research, http://en.wikipedia.org/wiki/Phases_of_clinical_research

Appendix: The Economic Impact of FinTech

- 36 UKTI and EY (2014) Landscaping UK Fintech. Available at: [http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/\\$FILE/EY-Landscaping-UK-Fintech.pdf](http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/$FILE/EY-Landscaping-UK-Fintech.pdf) (accessed 11 March 2015).
- 37 TheCityUK (2014) Investing in Britain's Future. Available at <http://www.thecityuk.com/research/our-work/reports-list/investing-in-britain-s-future/> (accessed 11 March 2015).
- 38 City of London (2013) The UK – world-class in financial services. Available at <https://www.cityoflondon.gov.uk/about-the-city/what-we-do/Documents/the-uk-world-class.pdf> (accessed 11 March 2015).
- 39 UKTI and EY (2014) Landscaping UK Fintech. Available at: [http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/\\$FILE/EY-Landscaping-UK-Fintech.pdf](http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/$FILE/EY-Landscaping-UK-Fintech.pdf) (accessed 11 March 2015).
- 40 Accenture (2014) The Boom in Global Fintech Investment: A new growth opportunity for London. Available at: <http://www.accenture.com/Microsites/fsinsights/capital-markets-uk/Documents/Accenture-Global-Boom-in-Fintech-Investment.pdf> (accessed 12 March 2015).
- 41 Gartner (2014) Forecast: Enterprise IT Spending for the Banking and Securities Market, Worldwide, 2011-2017, 4Q13 Update. Available at <http://www.gartner.com/doc/2659418/forecast-enterprise-it-spending-banking> (accessed 11 March 2015).
- 42 Nesta (2014) Understanding Alternative Finance. The UK Alternative Finance Industry Report 2014. Available at: <http://www.nesta.org.uk/sites/default/files/understanding-alternative-finance-2014.pdf> (accessed 12 March 2015).
- 43 Nesta (2014) Understanding Alternative Finance. The UK Alternative Finance Industry Report 2014. Available at: <http://www.nesta.org.uk/sites/default/files/understanding-alternative-finance-2014.pdf> (accessed 12 March 2015).
- 44 CMA (2014) Personal current accounts and small business banking not working well for customers. Available at <https://www.gov.uk/government/news/personal-current-accounts-and-small-business-banking-not-working-well-for-customers> (accessed 11 March 2015).
- 45 Department for Business, Innovation & Skills (2012) Boosting Finance Options for Business. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32230/12-668-boosting-finance-options-for-business.pdf (accessed 11 March 2015).
- 46 Nesta (2014) Understanding Alternative Finance. The UK Alternative Finance Industry Report 2014.

- Available at: <http://www.nesta.org.uk/sites/default/files/understanding-alternative-finance-2014.pdf> (accessed 12 March 2015).
- 47 Nesta (2014) Understanding Alternative Finance. The UK Alternative Finance Industry Report 2014. Available at: <http://www.nesta.org.uk/sites/default/files/understanding-alternative-finance-2014.pdf> (accessed 12 March 2015).
 - 48 Accenture (2014) The Boom in Global Fintech Investment: A new growth opportunity for London. Available at: <http://www.accenture.com/Microsites/fsinsights/capital-markets-uk/Documents/Accenture-Global-Boom-in-Fintech-Investment.pdf> (accessed 12 March 2015).
 - 49 KPMG (2014) Growing the UK tech sector: From start-ups to growth – creating the next wave of world class technology companies. Available at: <https://www.kpmgslant.co.uk/media/1193/growing-uk-tech-sector.pdf> (accessed 11 March 2015).
 - 50 FFintech50 (2014) Introducing the 50 most innovative and disruptive brands in financial technology for 2014. Available at: http://www.fintechcity.com/download/i/mark_dl/u/4012247731/4604777619/The%20FinTech50%202014.pdf (accessed 12 March 2015).
 - 51 Accenture (2014) The Boom in Global Fintech Investment: A new growth opportunity for London. Available at: <http://www.accenture.com/Microsites/fsinsights/capital-markets-uk/Documents/Accenture-Global-Boom-in-Fintech-Investment.pdf> (accessed 12 March 2015).
 - 52 Techcityinsider (2014) Boom time for London fintech. Available at <http://www.techcityinsider.net/boom-time-for-london-fintech/> (accessed 11 March 2015).
 - 53 Accenture (2014) The Boom in Global Fintech Investment: A new growth opportunity for London. Available at: <http://www.accenture.com/Microsites/fsinsights/capital-markets-uk/Documents/Accenture-Global-Boom-in-Fintech-Investment.pdf> (accessed 12 March 2015).
 - 54 Fintech50 (2014) Introducing the 50 Most Innovative and Disruptive Brands in Financial Technology for 2014. Available at: http://www.fintechcity.com/download/i/mark_dl/u/4012247731/4604777619/The%20FinTech50%202014.pdf (accessed 12 March 2015).
 - 55 Fintech50 (2014) Introducing the 50 Most Innovative and Disruptive Brands in Financial Technology for 2014. Available at: http://www.fintechcity.com/download/i/mark_dl/u/4012247731/4604777619/The%20FinTech50%202014.pdf (accessed 12 March 2015).
 - 56 UKTI and EY (2014) Landscaping UK Fintech. Available at: [http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/\\$FILE/EY-Landscaping-UK-Fintech.pdf](http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/$FILE/EY-Landscaping-UK-Fintech.pdf) (accessed 11 March 2015).
 - 57 Nesta (2015) The Geography of the UK's Creative and High-Tech Economies. Available at: http://www.nesta.org.uk/sites/default/files/geography_uks_creative_high-tech_economieswv20151.pdf (accessed 12 March 2015).
 - 58 Accenture (2014) The Boom in Global Fintech Investment: A new growth opportunity for London. Available at: <http://www.accenture.com/Microsites/fsinsights/capital-markets-uk/Documents/Accenture-Global-Boom-in-Fintech-Investment.pdf> (accessed 12 March 2015).
 - 59 KPMG (2014) Growing the UK tech sector: From start-ups to growth – creating the next wave of world class technology companies. Available at: <https://www.kpmgslant.co.uk/media/1193/growing-uk-tech-sector.pdf> (accessed 11 March 2015).
 - 60 Financial Times (2014) UK banks axe branches in favour of digital model. Available at <http://www.ft.com/cms/s/0/5ea06dae-5adb-11e4-8625-00144feab7de.html#axzz3Lh44mcaC> (accessed 11 March 2015).
 - 61 Forbes (2015) Banks Beware: TransferWise Raises \$58 Million To Go Global. Available at <http://www.forbes.com/sites/parmyolson/2015/01/26/transferwise-funding-andreessen-banks/> (accessed 11 March 2015).
 - 62 Office for National Statistics (2014) Internet Access – Households and Individuals. Available at: <http://www.ons.gov.uk/ons/rel/rdit2/internet-access---households-and-individuals/2014/stb-ia-2014.html> (accessed 12 March 2015).
 - 63 Nesta (2014) Understanding Alternative Finance. The UK Alternative Finance Industry Report 2014. Available at: <http://www.nesta.org.uk/sites/default/files/understanding-alternative-finance-2014.pdf> (accessed 12 March 2015).
 - 64 UKTI and EY (2014) Landscaping UK Fintech. Available at: [http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/\\$FILE/EY-Landscaping-UK-Fintech.pdf](http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/$FILE/EY-Landscaping-UK-Fintech.pdf) (accessed 11 March 2015).
 - 65 Nesta (2014) Understanding Alternative Finance. The UK Alternative Finance Industry Report 2014. Available at: <http://www.nesta.org.uk/sites/default/files/understanding-alternative-finance-2014.pdf> (accessed 12 March 2015).
 - 66 UKTI and EY (2014) Landscaping UK Fintech. Available at: [http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/\\$FILE/EY-Landscaping-UK-Fintech.pdf](http://www.ey.com/Publication/vwLUAssets/Landscaping_UK_Fintech/$FILE/EY-Landscaping-UK-Fintech.pdf) (accessed 11 March 2015).



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