Financial Technology Law – A New Beginning and a New Future

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I. Introduction

Banking and financial markets have been subject to significant change in recent decades. Markets have benefited from substantial advances in all forms of technological operation including computer hardware and software capability, massive downsizing in circuitry and processors, telecommunications speed and efficiency, mobile access, in particular, through mobile telephony, tablets, and other hand-held devices, and wearables, and substantial reductions in manufacturing and service costs.

Parallel deregulatory processes in many market sectors including banking, securities, and insurance as well as telecommunications and media services have accompanied all of this. Deregulation has substantially increased capital and investment flows in banking and financial markets which has, in turn, increased liquidity and reduced borrowing and funding costs significantly.

International financial markets are nevertheless also still dealing with the significant costs and impacts of the global financial crisis beginning in 2007–2008. Substantial recent advances in financial technology and FinTech service and product models have then created important possible opportunities for growth with increased efficiency and earnings in the aftermath of the crisis; although, this has also created significant new threats especially in terms of market and counterparty fragmentation, and consequent regulatory and supervisory dislocation, disconnection, division, depletion, and distraction as well as a resource demand and potential skills deficit.

FinTech has emerged as a powerful new market force as a result of the coming together of a number of disconnected trends. Significant advances have occurred in the areas of computer and digital technology, the Internet, mobile telecommunications as well as economics and finance, which have transformed traditional areas of study and created important potential new business structures and operations. The Internet, or World Wide Web (www), has specifically emerged from two earlier phases of the static Net 1, 1

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1. The Internet forms the underlying network infrastructure that connects computers with the World Wide Web constituting a specific language based on http (hypertext transfer)
to the interactive Net 2, with the current phase constituting the beginning of Net 3, or the Value Net or Value Web, and the full realization of the potential to digitalize and monetize all online banking and financial and other products and services. Net 4 is expected to follow this, with the semantic or machine Net, and then the immersive or sensory Net 5. All of this can be considered to be associated with the emergence of the digitalization, mobilization, disintermediation, personalization, and democratization of financial services activities and functions. All industries will have to become aware of the possibilities of disruptive technology replacing existing industrial business structures, products, and services. Law and regulation have been sensitive to these changes although slow to respond to date with no meaningful coherent program constructed to date.

The purpose of this paper is to examine the meaning and nature of FinTech and other associated terms including regulatory technology (RegTech), incubators, accelerators and catapults, law technology (LawTech), electronic banking and finance, digital currencies, and the digital economy. Market size and location studies are referred to. The FinTech market is explained in terms of its various sub-sectors and components. The specific technology underlying distributed ledgers and some of the most recent developments in digital currencies are also considered. Relative advantages and disadvantages of this new exciting market area are noted with a provisional set of comments and conclusions drawn on its current and potential future value and direction. It has to be stressed that these can only be understood through a protocol that allows the sharing of information in a common format. See generally Tim Berners-Lee, Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web by Its Inventor (Harper New York 1999).

2. Skinner describes the Value Net in terms of financial markets having moved from paper-based localized systems to online digital models that allow the transfer of value in real time at almost zero cost. See generally Chris Skinner, Value Web: How Fintech Firms Are Using Mobile and Blockchain Technologies to Create the Internet of Value (Marshall Cavendish Business 2016).

3. This is also referred to as the “internet of things” (IoT) or internet of objects (IoO). The term was first referred to by Kevin Ashton to refer to inter-connected devices in 1999. Alex Wood, The Internet of Things is Revolutionising Our Lives, but Standards are a Must, The Guardian (Mar. 31, 2015), https://www.theguardian.com/media-network/2015/mar/31/the-internet-of-things-is-revolutionising-our-lives-but-standards-are-a-must. Berners-Lee has referred to Web 3.0 as the Semantic Web, or Linked Data, which involves the development of common data formats and exchange protocols to allow data transfer between computers and systems. This is included with Net 4.0 and the machine net for the purposes of this paper. See Tim Berners-Lee, James Hendler & Ora Lassila, The Semantic Web, Scientific American Magazine (May 2001), http://www.scientificamerican.com/article/the-semantic-web/.

4. This refers to a further highly personalized stage where people effectively live inside the Internet. Skinner refers to this as with 4.0 and predicts that it will arrive around 2015. See generally Chris Skinner, Value Web: How Fintech Firms Are Using Mobile and Blockchain Technologies to Create the Internet of Value (Marshall Cavendish Business 2016).

be considered to be pre-emptive and exploratory observations at this stage in light of the new and fast changing nature of the subject matters covered.

II. Financial Technology and FinTech Language

The substantial growth in FinTech technologies and applications in recent years has been associated with the emergence of a new technical and media language. This is in addition to the general digitalization, mobilization, disintermediation, personalization, and democratization of financial services activities and functions referred to. FinTech has been associated with a growth in incubators, accelerators, catapults, and regulatory sandboxes, which provide different forms of support services for early start-up companies.6 Start-up companies are commonly referred to as unicorns, with an initial market value of over $1 billion, decacorns, with a value of over $10 billion, and most recently hectocorns, with $100 billion. Groups of FinTech companies are also often referred to in collective terms such as with Fangs,7 BEGgarss MisFiTs,9 and BANTS.io.

This is an exciting area of study, although, one in which the limitations of current language become apparent. A number of new terms, or neologisms, and specifically syllabic abbreviations on predictive translations,10 are

7. Facebook (estimated market value $307 billion), Amazon ($230 billion), Netflix ($42 billion), and Google ($503 billion). Apple ($534 billion) may also be included. See, e.g., Julia Greenberg, The Market Wants Tech Companies to Prove Their Worth, Wired (Jan. 20, 2016), http://www.wired.com/2016/01/the-market-wants-tech-companies-to-prove-their-worth/.
10. See Syllabic Abbreviation, WORLD HERITAGE ENCYCLOPEDIA (2002), http://www.self.gutenberg.org/articles/syllabic_abbreviation. Syllabic abbreviations are words made from syllables from existing words. Syllabic abbreviations used in this text include TechLaw, TechReg, BankTech, CoinTech, LoanTech, PayTech, SecTech or TradeTech, InsurTech, InterTech, GovTech as well as SmartTech for smart contracts, TechRisk and FinRisk, and FinReg, SuperTech, ResTech, SupTech (or TLR), and the NonNet. Predictive translations are used to refer to the expected Latin terms for modern areas of law such as lex digitalis, lex...
accordingly developed through this paper. The objective is not to confuse but to contribute to the emergence of the useful new technical vocabulary and language under construction in this area.

A. Financial Technology and Fintech

Financial Technology (FinTech) refers to the use of technology in the banking and financial area. There is no official definition of the term and it is often used in different ways by different writers and in different reports. FinTech was originally used to refer to a Citicorp (now Citigroup) Financial Services Technology Consortium to promote rather than obstruct technological cooperation with outside firms. The term was initially used to signify technological cooperation between new market entrants and incumbent firms, although, many now only discuss FinTech in terms of disruption.

FinTech can generally be understood in terms of the electrification and digitalization of banking and financial services, bank accounts and ledgers, and their use in innovative and unconventional ways. FinTech can be defined either in terms of market function, market institutions, market technology, market structure, or market impact and disruption. FinTech has, for example, been defined as referring “to technology enabled financial solutions” or “to the use of technology to deliver financial solutions.” Solutions can be understood in terms of functions, which, for the purposes

12. Citicorp had a reputation for resisting such collaboration and set up the Consortium to reverse this reputation with Citicorp also being involved in a separate Smart Card Forum. See Marc Hochstein, FinTech (the Word, That Is) Evolves, AMERICAN BANKER (Oct. 5, 2015), http://www.americanbanker.com/bankthink/fintech-the-word-that-is-evolves-1077098-1.html.

13. Catherine A. Allen, who assisted develop the Smart Card Forum, refers to Citicorp (Citigroup) adopting a new “language of cooperation between companies and across industries” and as having “shed its historical insistence on calling its own technological tune.” Citicorp had earlier adopted an Automated Teller Machine (ATM) system in the 1970s based on its own Magic Middle System, which was incompatible with other machines. The Smart Card Forum promoted common standards between 30 and up to 60 operators. Allen had stated that, “Citicorp is participating because times have changed” and that “Cooperation is necessary for common industry standards.” See Jeffrey Kutler, Citibank is Shedding Individualistic Image, AMERICAN BANKER (Sept. 25, 2015), http://www.americanbanker.com/bankthink/friday-flashback-did-citi-coin-the-term-fintech-1076875-1.html.

14. For the purposes of this text, electronic is understood to refer to anything relating to the use of electronic circuits, devices or systems including computers and mobile telecommunications instruments. Digital refers to programming based on discontinuous data inputs (0 and 1) or binary digits (bits) rather than continuous analogue measures which digital programs replicate. (A byte consists of 8 bits.) Electronic accordingly generally refers to devices and digital to programming. Bits and Bytes, https://web.stanford.edu/class/cs101/bits-bytes.html.

of this text, consist of savings and deposit, lending and credit, payment, investment and risk, or loss management.

Other definitions consider FinTech in terms of the companies rather than markets concerned. The report on UK FinTech commissioned by HM Treasury and prepared by Ernst & Young in March 2015 adopts an entity-based approach.\textsuperscript{16} This defines “FinTechs as high-growth organizations combining innovative business models and technology to enable, enhance and disrupt [financial services].”\textsuperscript{17} Ernst & Young also identify certain common characteristics focusing on consumers, user experience, low costs, and simple modelling.\textsuperscript{18} The report generally adopts a “Classic” classification of FinTech characteristics (based on Customer-centric, Legacy-free, Asset light, Scalable, Simple, Innovative, and Compliance light), which follows the earlier LASIC principles developed by David Chuen and Ernie Teo.\textsuperscript{19} The FinTech sector would then include start-ups and new entrants as well as scale-ups (expanding), maturing companies, and non-financial services companies, including telecommunication providers and e-retailers.\textsuperscript{20} While this adopts an institutional approach, it also emphasizes characteristics and impact in terms of enabling, enhancement, and disruption.

Other reports adopt a technological approach. Separate UK government commissioned official reports refer to FinTech generally as “technology applied to financial services” or the use of financial technology to provide financial services.\textsuperscript{21} Financial technology can be defined as innovation in financial services.\textsuperscript{22} The UK Government Chief Scientific Adviser, Sir Mark Walport, defines FinTech as “financial technologies that integrate finance and technology in ways that disrupt traditional financial models and businesses and provide an array of new services to businesses and consumers.”\textsuperscript{23} This stresses the “hybridization of technology with the traditional processes of finance—[including] working capital, supply chain, payments, processing, deposit accounts and life assurance . . . [which]
replaces traditional structures and working models with new technology-based processes.24

Many other definitions include reference to disruption with the implication that FinTech has to damage existing market positions.25 Disruption may be more generally understood simply in terms of market impact with any important new technological advance resulting in necessary systems and process changes. While many of the larger banks and other financial institutions may have resisted change previously, there is now active cooperation and participation in many areas.26 Small FinTech start-up companies and new market entrants are not disadvantaged by assuming the costs of managing multiple legacy systems at the same time as larger incumbents benefit from necessary capital pools, personnel, expertise, and other infrastructure as well as established client bases.27 While some FinTech companies have initially operated with a supporting bank and then expanded to such an extent that they are able to separate themselves, such as with TransferWise, many start-ups may simply sell their technology to existing incumbents or be taken over by them.28

The natural FinTech cycle will accordingly operate through a combination of internal technological investment as well as external competition, cooperation, product purchase, or outright corporate acquisition. While many new design products may have been set up to challenge the banking and financial industry, many start-ups will sell their products to a single bank and especially those that may have provided incubator or accelerator services.29 Wider industry change may then be dependent on the adoption of common industry standards and compatible systems by the incumbents themselves at the same time as they develop appropriate models to replace legacy systems.30 This could either be achieved on a parallel system, systems revision or more fundamental systems replacement model, or a combination of these. When uncompetitive incumbent institutions may have to leave the market, these may simply be absorbed into other existing firms or groups that have the capital and resources to manage the transferred clients and services.

The term FinTech can accordingly be used to refer to new functional delivery channels, new market entrants, new technologies, market challenge and disruption, or to the future of banking and finance more generally.31 FinTech is used in an inclusive and constructive manner in this text.

24. Id.
25. See, e.g., id. at 21.
26. See, Hochstein, supra note 12; see also, Kutler, supra note 13.
27. See Walport, supra note 23.
29. See, Waters, supra note 5.
30. See Walport, supra note 23, at 21-22.
31. The term FinTech is used for the purposes of this text to refer to the new marketplace as a whole including new entrants and incumbents. Marc Hochstein notes that the term has
B. Regulatory Technology or RegTech

Regulatory technology (RegTech) refers to the use of financial technologies for regulatory and supervisory purposes. The UK Government’s Chief Scientific Adviser refers to this in terms of “regulatory technologies encompass[ing] any technological innovation that can be applied to or used in regulation typically, to improve efficiency and transparency.” Technology can be used to assist both internal firm conduct, and misconduct, surveillance and penalties, as well as, external forward-looking supervisory and early intervention action by regulatory authorities. The separate more general term technology regulation (or TechReg) is used in this paper to refer to the new regulatory structure adopted to deal with expanding technology as a whole rather than just the specific area of RegTech, which uses technology for internal compliance purposes.

Some of the issues involved were examined by the Bank of England in its Fair and Effective Market Review in June 2015, which recommended that firms had to improve surveillance while authorities strengthened regulatory approaches and with HM Treasury separately recommending that the most appropriate regulatory tools were used by authorities in particular cases. Relevant technological tools included pattern analysis, big data techniques, predictive coding, and digitalization of voice communications. RegTech may also assist develop data driven regulation and compliance, regulatory infrastructure and training, and education.

C. Distributed Ledgers

Distributed ledgers are based on mathematical algorithms, or structured programs, that can act as powerful, “disruptive innovations that could transform the delivery of public and private services and enhance...”

“become a ‘common noun’” with FinTech although the term has also been used to refer to types of company and in company names with different spellings and upper and lower case combinations. Hochstein “doubt[s] that another company will be able to claim the word as its own again.” Marc Hochstein, FinTech (the Word, That Is) Evolves, AMERICAN BANKER (Oct. 5, 2015), http://www.americanbanker.com/bankthink/fintech-the-word-that-is-evolves-1077098-1.html.

32. See Walport, supra note 23, at 47.
35. See Walport, supra note 23, at 48-49.
36. See id. at 49-51.
productivity through a wide range of applications." Block chain algorithms specifically allow transactions, or transfers, to be aggregated into blocks and added to existing chains using public and private key cryptography. The fundamental difference between digital currencies and conventional currency is that they avoid the need for intermediaries, including central banks and commercial banks, through the creation of a global "collaborative" endeavour.

Distributed ledgers operate through the maintenance of multiple shared copies of the database which avoids single point attack or failure as with existing large legacy IT systems. Legacy systems are costly and administratively burdensome to maintain and often suffer from significant complexity and connectivity problems. They also become easily out of date and can be manipulated without detection either through the abuse of authorized passwords or hacking.

Distributed ledger technologies could also be used to allow governments to collect taxes, deliver welfare benefits, issue passports and control immigration, maintain land registries as well as manage the supply of goods and services and ensure the integrity of government records and services. Health services may specifically be assisted through the managed provision and authentication of service delivery and through the sharing of confidential records in accordance with prescribed rules. This should in turn allow end users the ability to limit and control access to their data files, as well as monitor any access use.

D. LAW TECHNOLOGY AND FINANCIAL TECHNOLOGY LAW

LawTech refers to the use of technology to improve legal business management and services more generally. This is again often based on computer databases and algorithms, in particular, for legal research, proof reading and document validation. The wider term Technology Law (TechLaw) is used in this paper to refer to the law governing the Internet and telecommunications including computer law. TechReg can be used to refer to the regulation applied to technology and FinReg the regulation governing FinTech specifically. RegTech, TechReg and FinReg are

38. See id. at 21.
39. See id. at 6.
40. Id.
41. Id.
42. Id.
43. Relevant issues are, for example, discussed at various LawTech Futures events with relevant issues also being examined by the British Legal Technology Forum. See BRITISH LEGAL TECH. FORUM 2017, https://britishlegalitforum.com/ (last visited Aug. 30, 2016).
collectively referred to as Financial Technology Law or lex technologica financialis for the purposes of this paper.\textsuperscript{44}

E. INCUBATORS, ACCELERATORS, LABORATORIES, FACTORIES AND CATAPULTS

FinTech has been associated with a growth in Incubators and Accelerators, which provide different forms of support services for early start-up companies. Incubators may cover a wide market area or focus on specific sectors; incubators provide start-up companies with workspace, possible administrative and personnel support as well as possible funding support. Furthermore, incubators often co-work with other start-up companies within the incubator facility. Shared resources are provided with experienced support staff and mentorship. Incubation periods may be flexible. Government entities, financial institutions and other corporations and possibly venture capital firms generally provide incubator services.\textsuperscript{45}

Accelerators assist operational companies grow and expand their business. This may again include workspace with network access and seed investment although accelerator programs tend to be more flexible than incubator structured services.\textsuperscript{46} FinTech factories or laboratories can be considered to constitute internal development facilities for banks and other financial situations to develop their own innovative products, services and systems for their customers.\textsuperscript{47} Digital catapults generally consist of innovation centers designed to support innovative companies within a digital community.\textsuperscript{48} FinTech hubs tend to focus on cooperative research and innovation although

\textsuperscript{44} See Syllabic Abbreviation, supra note 11.
the term hub can also be used as a collective term for any group of activities, which may include any of the above.

F. ELETrONIC BANKing AND FINANCE

FinTech can also be understood with reference to other existing areas of financial development. E-banking refers to any banking activity carried out using electronic devices and digital banking to any services provided through pre-loaded computer programs. E-finance can be understood to refer to any financial activities carried on using electronic or digital devices, including electronic trading, electronic money, electronic payment and communication. Internet banking refers to the provision of any banking services over the Internet. E-money consists of stored value or prepaid payment devices that allow payment to be made. E-trading refers to the conduct of market making (principle) or brokerage (agency) dealing in securities using electronic devices.

G. DIGITAL CURRENCIES

Digital or virtual currencies generally consist of private token or coin systems issued in a digital form. The International Monetary Fund (IMF) examined virtual currencies, which were defined as “digital representations of value, issued by private developers and dominated in the own unit of account.” The European Central Bank (ECB) considered the nature and impact of virtual currency schemes on central banks in October 2012 and February 2015. The documents define virtual currencies as any “type of unregulated, digital money, which is issued and usually controlled by its

50. The Basel Committee defines electronic money as any stored value or prepaid payment mechanisms permitting payment to be effected “via point of sale terminals, direct transfers between two devices, or over open computer networks such as the Internet.” Electronic money may include “‘hardware’ or ‘card-based’ mechanisms (also called ‘electronic purses’) and ‘software’ or ‘network-based’ mechanisms (also called ‘digital cash’).” Basel Committee, Risk Management for Electronic Banking and Electronic Money Activities (Mar. 1998) at 3, https://www.bis.org/publ/bcbsc215.pdf.
51. This includes electronic trading systems which are defined by the Committee on the Global Financial System (CGFS) defines an electronic trading system as a “facility that provides some or all of the following services: electronic order routing (the delivery of orders from users to the execution system), automated trade execution (the transformation of orders into trades) and electronic dissemination of pre-trade (bid/offer quotes and depth) and post-trade information (transaction price and volume data).” CGFS, THE IMPLICATIONS OF ELECTRONIC TRADING IN FINANCIAL MARKETS 3 (2016), http://www.bis.org/publ/cgfs16.pdf.
developers and used and accepted among the members of a specific virtual community. Three types of scheme are distinguished. A number of different purposes are established including virtual community use, float revenue generation, business flexibility, and traditional currency competition. The paper provides a short historical review of money and the nature of money in a virtual world. The nature of virtual currency schemes is examined and two case studies provided of Bitcoin and the Second Life scheme.

The Committee on Payments and Market Infrastructures (CPMI) issued a paper on Digital currencies in November 2015. While previous CPMI reports referred to virtual and cryptocurrencies, the preferred term has become digital currencies. The report identifies three features of digital currencies with the assets having some monetary characteristics but not tied to a sovereign currency, transfers through distributed ledgers and principal development through non-bank institutions. Specific issues were referred to in terms of global use, lower cost and increased security and trust. The report explains the key features and uses of digital currencies and examines factors influencing the development of digital currency markets including supply and demand side factors and the role of regulation.

The Bank of England has issued a number of papers on digital currencies. The Bank distinguishes four types of innovative payment technology: wrappers (services which improve user interface and accessibility to existing payment systems architecture), mobile money (with value stored on smart cards or system-providers’ books), credits and local currencies (alternative

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55. Digital currencies provide for the purchase of goods or services online without physical coins and banknotes or the use of bank account transfer systems. These include software based models, referred to as cryptocurrencies, although virtual currencies have restricted use within a specific online community. Type 1 consists of closed virtual currency schemes; type 2 operate on the basis of a unidirectional flow which allows the purchase of virtual goods and services; and type 3 currencies with bidirectional flows which can be used to purchase virtual or real goods and services. Id.
56. Id.
57. Id. at 9-12.
58. See id. at 21-32. The ECB has examined the implications of the Second Life Scheme established by Linden Research Inc. in June 2003 to support a “multiplayer online role-playing game.” Id.
60. Id. at 1 n.2.
61. Id. at 1.
62. A taxonomy of money and exchange mechanisms including physical, electronic and digital systems is provided. Id. at 1 fig.6.
63. Id. at 4–7.
64. Id. at 7-11.

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units of account purchased with money), and digital currencies (including decentralized payment systems and currencies with most of these being based on cryptography and constituting cryptocurrencies). These can be contrasted from other online fantasy currencies used for gaming and other non-monetary purposes on the Internet. The evolution of payment technology is examined with modern payment systems contrasted with new innovative techniques. The nature of Bitcoin is referred to and importance of the distributed ledger as a key technological innovation within payment systems and beyond. The Bank also studied the economics and macroeconomics of digital currencies.

H. DIGITAL ECONOMY

FinTech will form an important part of the development of new Digital Economies. The Digital Economy and digital society can be considered to constitute those parts of the economy and society operating through or tied to digital systems including principally the Internet and digital telecommunications. It was estimated that in 2015, the digital economy represented around 22.5 percent of the world economy, or $19,159 billion, and which would grow to 25 percent by 2020, or $24,615 billion.

Although the terms are not separately defined, the digital economy and digital society are referred to by the European Commission as part of its Digital Single Market program. The DSM is explained in terms of the free movement of goods, persons, services and capital with citizens, individuals and businesses having seamless access to and being able to exercise online activities under conditions of fair competition and with a high level of consumer and personal data protection irrespective of nationality or residence. The DSM has been referred to as one of the Commission's top priorities managed through The European Commission Directorate General for Communications Networks, Content & Technology.

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based on three pillars: access, conditions, and growth.69 The Commission has specifically consulted on the regulatory environment for Digital Platforms; including online intermediaries, data and cloud computing, and the collaborative economy.70 The cloud and cloud services consist of pooled data storage and processing facilities made available through the Internet on a demand basis.71

The UK Government has been promoting the use of technology more generally and the establishment of a Digital Economy including assisting with the establishment of the European Union (EU)'s Digital Economy. The Government published a Blueprint for Technology in 2010, which focused on supporting technology based innovation within the UK.72 Innovate UK was set up as an executive non-departmental public body sponsored by the Department for Business, Innovation & Skills to promote science and technological innovation.73 Innovate UK produced a Digital Economy Strategy 2015-2018 in 2015.74

The Office for National Statistics (ONS) conducted a consultation on Measuring the Digital Economy from August to October 201475 with a new annual bulletin to be produced. The Government also set out its vision for the EU's digital economy, which identified existing problems and set out 13 recommendations based on increased mobility and security and innovation

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71. Cloud computing allows for the delivery of computing resources as a utility service through a network on a "flexible, location-independent basis that allows for rapid and seamless allocation of resources on demand." CLOUD COMPUTING LAW 3 (Cristopher Millard ed. 2013). The largest cloud services providers were Amazon Web Services and Microsoft followed by Google and other more specialist firms such Rackspace, Virtustream, CenturyLink and VMware. Magic Quadrant for Cloud Infrastructure as a Service, Worldwide, GARTNER (Aug. 3, 2016) fig.1, https://www.gartner.com/doc/reprints?id=1-2G2O3FC&ct=150519.

72. HM GOVERNMENT, BLUEPRINT FOR TECHNOLOGY, 2010.


74. This strategy set out how the Government would spend £30 million every year for four years to support innovative business projects including funding for the Digital Catapult Center, Open Data Institute and Tech City UK. INNOVATE UK, DIGITAL ECONOMY STRATEGY 2015-2018, 2015.

75. See OFFICE FOR NATIONAL STATISTICS, CONSULTATION ON MEASURING THE DIGITAL ECONOMY, 2014; OFFICE FOR NATIONAL STATISTICS, RESPONSE TO THE ONS CONSULTATION ON MEASURING THE DIGITAL ECONOMY, 2014.
through competition.76 Furthermore, a 2009 Digital Britain report contained a number of recommendations on extending broadband access, Internet use and revision to public service broadcasting.77 The US has one of the most sophisticated digital economies, although this has to a significant extent been market led and it is largely market-led.78 The Department of Commerce released a Digital Economy Agenda in February 2016.79 This Report listed a series of “Grand Policy Challenges” based on the global free exchange of information, online trust and security, access and skills and innovation and emerging technologies. A series of associated opportunities and policy priorities were highlighted for 2016 with a number of structural initiatives including the establishment of a Digital Economy Board of Advisers (DEBA), export assistance and the development of commerce “Policy Labs.”80

### III. FinTech Market Size

FinTech activity has grown substantially in recent years. FinTech is expected to grow even further in the future although this may be partly offset by a decline in traditional financial services earnings. FinTech is expected to disrupt many areas of activity including automotive and telematics (telecommunications and informatics such as navigation systems), media and micro-payments, healthcare and insurance and real estate and mortgage investing.81 It is estimated that one third of jobs in the banking area could be lost with legacy firms losing 20 percent of the business.82 Only 72 percent of senior banking executives considered that they had a proper strategy in place to deal with digital innovation.83

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77. DEPARTMENT FOR CULTURE, MEDIA AND SPORTS AND DEPARTMENT FOR BUSINESS INNOVATION AND SKILLS, DIGITAL BRITAIN: FINAL REPORT, 2009, Cm. 7650, at 53, 63, 136 (UK).
78. The U.S. had the largest digital economy in 2015, making up 33 percent of the gross domestic product at a value of about $5.9 trillion. MARK KNECHTEL, BRUNO BERTHON & PAUL DAUGHERTY, ACCENTURE, DIGITAL DISRUPTION: THE GROWTH MULTIPLIER 4 (2016).
79. The digital economy accounted for 5 percent of gross domestic product (GDP). In the US the digital economy is estimated to boost US GDP by up to $2.2 trillion by 2025. The US was the largest global export of services and exported $662 billion in 2013. ALAN DAVIDSON, U.S. DEP’T OF COMMERCE, DIGITAL ECONOMY AGENDA 3 (2016).
80. Id. at 7.
81. GOV’T OFFICE FOR SCI., supra note 37, at 55.
In 2014, FinTech was worth between $12 billion and $197 billion in investment around the world.\textsuperscript{84} It was estimated that UK FinTech generates around £20 billion in annual revenue.\textsuperscript{85} This included £10 billion in payments, £4.2 billion in financial software, £3.8 billion in financial data and analytics, and £2 billion in platforms.\textsuperscript{86} Banking and securities firms spent around £319 billion ($485 billion) on IT in 2014.\textsuperscript{87} Financial services in the United Kingdom represented around 9.6 percent of gross domestic product (GDP) and 14.5 percent of GDP after the inclusion of professional services.\textsuperscript{88} Internet-related services generated around 8.3 percent of GDP.\textsuperscript{89} Over 2.4 million people worked in high technology industries in the United Kingdom, with 825,000 of these in science, technology, engineering and mathematics (STEM) positions and 135,000 of these involved with financial services technology.\textsuperscript{90}

In 2014, the United Kingdom had a large digitally active user base, with 91 percent of adults having Internet broadband access and 58 percent of adults having mobile phone Internet access.\textsuperscript{91} The Government Office for Science reported that 58 percent of consumers were aware of alternative finance, but only 14 percent had used it.\textsuperscript{92} Paralleling this awareness, in 2013 consumers were found to have a very low confidence level of 23 percent in U.K. banks.\textsuperscript{93}


\textsuperscript{85} Walport, supra note 23, at 2.

\textsuperscript{86} Id.


\textsuperscript{92} Walport, supra note 23, at 58.

\textsuperscript{93} ERNST & YOUNG, supra note 17, at 10.
IV. FinTech Market Centers

FinTech activities have been growing substantially across the world. The seven leading FinTech centers are in the United Kingdom, California, New York, Singapore, Germany, Australia, and Hong Kong. A 2016 Ernst & Young report on the progress of FinTech globally for the prior year (EY Cutting Edge Report) confirmed that the United Kingdom remained the most significant FinTech ecosystem across four attribute categories: talent, capital, policy, and demand.94 In terms of capital, the U.K. FinTech market was estimated to be around £6.6 billion; New York at £5.6 billion, California at £4.7 billion, Germany at £1.8 billion, Australia at £0.7 billion, and Singapore and Hong Kong at £0.6 billion.95

The EY Cutting Edge Report further described the United Kingdom as an “all-rounder,” with £6.6 billion in market size, £524 million in investment and 61,000 FinTech staff.96 The report also noted that the United Kingdom had a “very good pool of talent, with exceptional access to financial expertise,” with concerns remaining about the “future tech talent pipeline,” but California led overall for the talent category.97 Capital availability in the United Kingdom was strong, especially for early-stage investment, but California remained the dominant FinTech center in this category as well.98 For the policy category, the United Kingdom was considered to have “the strongest FinTech policy environment with the most supportive regulatory regime,” including the FCA’s Innovation Hub and Project Innovate, but Singapore and Australia were described as “increasingly progressive.”99 As far as demand went, FinTech demand remained healthy in the United Kingdom due to London’s position as an international financial center, but demand was also strong in New York, evidenced by “the highest rate of consumer adoption.”100 California was described as “established and efficient,” New York as “proximity to expertise and customers,” Singapore “increasingly progressive regulatory regime,” Germany “large but complex,” Australia “up and coming” and Hong Kong “potential.”101

The EY report warns that the United Kingdom’s dominant position could be lost with the increase of policy initiatives by other markets, the emergence of specialist regions, and China’s potential to become the largest FinTech provider in the world.102 China is home to seven of the world’s thirty-one FinTech unicorns, with the Chinese FinTech sector concentrated

94. Id. at 10-11, 14-15.
95. Id. at 14-15.
96. Id. at 14.
97. Id. at 10.
98. Id.
99. Id. at 11.
100. ERNST & YOUNG, supra note 17, at 11.
101. Id. at 14-15.
102. Id. at 16.
in Beijing. The EY Cutting Edge Report develops two scenario analyses for the United Kingdom based on a “policy momentum loss” situation and a “proactive FinTech agenda” course of action, and formulates nine recommendations to protect the United Kingdom’s position as the lead provider of FinTech.

V. FinTech Market

Globally, the FinTech market has grown substantially and continues to show potential for further growth across all market sector areas. Electronic and digital systems were earlier used in the securities area, especially with the development of links between traditional stock markets and exchanges and then the development of new electronic markets. Investment firms utilized these systems to develop early forms of algorithmic trading, high frequency trading (HFT), and off-market dark and grey pools.

There were estimated to be around 4000 FinTech start-ups at the end of 2015, with over twelve considered “unicorns” — meaning they have a market valuation of over $1 billion. The most substantial innovations occurred in the area of retail payments, and these changes have specifically led to the unbundling of a number of more traditional financial services and the turn to low-cost foreign exchange (FX) services by firms. More recently, advances have occurred in the payments area with integrated payment systems, contactless payments, peer-to-peer payments and lending, debt

103. The EY Cutting Edge Report notes that Beijing’s venture capital (VC) market grew from £1 billion in 2012 to £8.6 billion in 2015, second only to San Francisco. Regulatory authorities in China supported FinTech companies and allowed them to expand substantially. Alibaba, for example, was found to process over eighty million transactions per day with a $65 billion online money market fund. Id. at 16.

104. These recommendations are: (1) create a FinTech “delivery body” to drive high impact policy initiatives to implementation as quickly as possible; (2) build on the FCA’s position as the most progressive regulatory body globally; (3) deliver practical business support to FinTechs; (4) build FinTech “bridges” to support UK FinTechs expand internationally; (5) strengthen the UK’s talent pipeline especially on tech talent; (6) establish regional “Centres of Excellence” in the UK; (7) initiate investor-focused programmes to improve access to growth capital; (8) broaden tax initiatives to drive greater investment in UK FinTech; and (9) promote government, consumer and financial institution adoption of FinTech services. Id. at 17-19.

105. These include electronic communication networks (ECNs) in the United States, alternative trading systems and alternative trading platforms (ATSs and ATPs) in the United Kingdom and multilateral trading facilities (MTFs) and organized trading facilities (OTFs) as well as firm based internal markets (internalization) in the E.U. See FINANCIAL MARKETS AND EXCHANGES LAW 9-10 (Michael Blair QC, George Walker & Stuart Willey eds., 2013).


crowdfunding, and money management tools. Further expansion is expected in identity management, financial inclusion, and off-rail payments. Lending has principally grown in the peer-to-peer sector and crowdfunding. Shares can also be purchased on a low contribution basis through equity crowdfunding.

Other innovative services, especially in connection with retail investments and pensions and investment management, wholesale banking, and capital markets have included engaged investing, visualization tools and the provision of algorithmic advice, or “robo-advice,” in addition to smart contracts. More general technological tools include machine learning and cognitive computing, big data analytics, optimization and fusion, and other future technologies, such as the Internet of Things and the Semantic Web, and possible further innovation in the area of quantum—rather than digital—computing.

A. DIGITAL BANKING (BankTech) AND DIGITAL CURRENCIES (CoinTech)

Early innovations in banking occurred through the use of computers for account and data processing and storage, electronic funds transfer, and later cash provision through automated teller machines (ATMs). More recent developments in digital banking have principally taken place through the establishment of online and Internet banks, as well as through innovations in

109. Ernst & Young, supra note 17, at 23, fig. 7.
110. Id.
111. Id. at 23, fig. 7; Why Fintech Won't Kill Banks, supra note 107 (explaining P2P lending). Peer-to-peer lending operates by the matching of fund lenders and borrowers directly either on a secured or unsecured basis subject to a management company or platform fee and credit checking charge.
113. Ernst & Young, supra note 17, at 23, fig. 7.
the production of private digital currencies. U.K.-only Internet banks include Atom Bank (established 2016), Tide (2016), OakNorth (2015), Starling (2014), Tandem (2015), Monzo (2015), and Smile (1999) formed by The Cooperative Bank.115 Goldman Sachs set up the digital bank, GS Bank, with Infosys, in 2016.116 Other significant U.S. online-only banks include Ally Bank, Discover Bank, Connexus Credit Union, First Internet Bank of Indiana, Bank of Internet USA, Capital One 360, iGoBanking, Alliant Credit Union, and Bank5 Connect.

Digital currencies are considered to be another online banking innovation. In 1990, DigiCash was originally developed by the American cryptographer David Lee Chaum using cryptographic protocols, however, DigiCash Inc filed for bankruptcy in 1998.117 In 1998, digital currencies progressed in the form of “b-money” by Wei Dai,118 while American cryptographer Nick Szabo proposed the development of “bit gold.”119 In July 2016, about 723 digital currencies existed, with a total market capitalization of $12.924 billion and a market capitalization of over $1 million for about seventy-four of these.120


119. Peck, supra note 118. Szabo developed the idea of solving cryptographic equations as proof-of-work which produced new coins. Szabo was concerned to remove the involvement of banks as trusted intermediaries as with Chaum’s DigiCash and have the new digital currency behave like gold without any central authority.

B. LENDING AND CREDIT (LoanTech)

Peer-to-peer lending began in the United Kingdom with Zopa in February 2005 and in the United States with Prosper in February 2006.\textsuperscript{121} Other U.S. companies include Lending Club (2007), OnDeck (2007), Kabbage (2009), Funding Circle (2010), Peerform (2010), CommonBond (2011), SoFi (2011), Upstart (2014), Affirm (2012), Avant (2012), and CircleBack Lending (2013).\textsuperscript{122} U.K. companies include Funding Circle, RateSetter (2010), and Quakle (2011). Other companies include MarketInvoice (2011), ThinCats (2011), Lending Works (2012), LendInvest (2013), and Landbay (2014). The U.K. government has invested over £85 million in peer-to-peer lending to smaller businesses.\textsuperscript{123} Major companies are members of the Peer-to-Peer Finance Association (P2PFA).\textsuperscript{124}

The Financial Conduct Authority (FCA) in the United Kingdom has regulated peer-to-peer lending and crowdfunding since April 1, 2014. Crowdfunding allows "people and business (including start-ups) . . . to raise money from the public to support a business, project, campaign or individual."\textsuperscript{125} The FCA is responsible for loan-based and investment-based crowdfunding rather than donation or pre-payment and rewards-based crowdfunding.\textsuperscript{126}

C. PAYMENT (PayTech)

A number of major innovations have taken place in the area of mobile payments through both FinTech start-up companies and established technology firms.\textsuperscript{127} Companies such as PayPal, which was initially set up in 1998 and acquired by eBay in 2002, developed new forms of electronic payments.\textsuperscript{128} By 2014, PayPal had 153 million digital wallets and processed around “$203 billion in payment volume” before being separately floated.

\textsuperscript{125} Crowdfunding, Fin. Conduct Auth. (June 10, 2016), https://www.the-fca.org.uk/consumers/crowdfunding.
\textsuperscript{126} Id.
\textsuperscript{128} Ranking the Top Fintech Companies, supra note 121; Michael J. De La Merced & Andrew Ross Sorkin, EBay Does About-Face in Spinoff of PayPal Backed by Icahn, N.Y. Times (Sept. 30,
again in 2015, with a market valuation of around £33 billion on September 6, 2014, Apple Pay was launched on the Apple iPhone 6. On May 15, 2013, Google Wallet was made available through Gmail. Other new payment providers include Klarna (2005), Payoneer (2005), Adyen (2006), Braintree (2007), Mozido (2008), Square (2009), Venmo (2009), and Stripe (2010). Other money transfer and currency innovators include Xoom (2001), TransferWise (2010), WorldRemit (2010), Coinbase (2012), Tilt (2012), and Circle (2013).

Venmo allows payments to be made through mobile telephones, and was acquired by Braintree in 2012 for $26.2 million; Braintree was then acquired by PayPal in 2013 for $800 million. Tilt is a crowdfunding platform that allows money to be collected and transferred between social groups. The largest online payment platform in China is Alipay, with 300 million customers; in 2004, it was set up as a payment vehicle within the market website Alibaba, and in 2011, it was separately incorporated for licensing purposes.

Wholesale payment markets have been dominated by improvements in market standards and harmonization such as with the Single Euro Payments Area (SEPA) and the second generation of the Trans-European Automated Real-time Gross Settlement Express Transfer System (TARGET2), which came into operation in November 2007. SEPA’s objective is to create a single cross-border payments market within the E.U. with TARGET2
establishing a real-time interbank payment system for euro transfers.\textsuperscript{138} TARGET2 is supported by TARGET2-Securities, which provides a centralized delivery versus payment (DvP) settlement system for European securities trades.\textsuperscript{139}

It was expected that national and international payment systems would have an “end-state” that was “largely unrecognizable” by 2020 due to the expansion of PayPal and the entry of “social media companies such as Amazon, Google and Facebook” into the payments market, with many developing countries simply “leapfrogging” into media development stages.\textsuperscript{140} Large technology and social media companies may be able to “leverage, even monetise, their considerable customer reach by presenting attractive, straightforward and secure payment propositions” with non-bank offerings which would dis-intermediate banks outside of the new global payments business.\textsuperscript{141} A number of banks were nevertheless responding to the challenges.\textsuperscript{142}

\subsection*{D. Securities and Investment (SecTech or TradeTech)}

Digitalization has already been used in the securities area especially with the dematerialization of many shares and bonds. Many country’s laws provide for the issuance of corporate shares or bonds and government debt instruments in an uncertificated or dematerialized form.\textsuperscript{143} Such dematerialization generally operates through the maintenance of a single, central register by the issuing company with the shares being dealt with either on over-the-counter markets, or through formal physical or electronic stock markets, which retain a separate admission to trading register. The earlier unregistered trading in over-the-counter (OTC) financial derivatives contracts has, to a substantial extent, been transferred to official counterparties (OCCs), with transaction records being kept through Trade Repositories (TRs). In the future, companies in a distributed ledger or block chain form could issue blocks of shares.

Important new companies in the securities area include MarketAxess (2000), Markit (2003), BATS Global (2005), IEX Group (2012), Kensho (2013), Digital Asset (2014), and TruMid Financial (2014).\textsuperscript{144}


141. \textit{Id.} at 3.

142. \textit{Id.} at 4.

143. See, e.g., \textit{The Uncertificated Securities Regulations, 2001 S.I. 2001/3755 (U.K.); see also U.C.C. art. 8 (stating that dematerialised securities may also be issued in the United States).}

144. \textit{Ranking the Top Fintech Companies, supra note 121.}}
personal finance and investment management companies include Envestnet (1999), Yodlee (1999), Mint (2006), Credit Karma (2007), Betterment (2008), LearnVest (2009), NerdWallet (2009), Personal Capital (2009), Motif (2010), and Wealthfront (2011).145

E. INSURANCE (INSURTECH) AND SMART CONTRACTS (SMARTTECH)

FinTech has also affected the insurance sector with current areas of development, including telematics (telecommunications and vehicle technology), social insurance, and wearable devices such as FitBit, with further growth expected in the areas of the Internet of Things, autonomous vehicles, and block chain.146 It was expected that “motor, home and mobile phone insurance” could be purchased “on a mutual or group basis” to allow collective savings.147

Digitalization could also be extended in the insurance area through the issuance of policies in a smart contract form.148 These digital contracts could provide for the collection of premia payments with policy payments being made automatically depending upon the terms and triggers agreed.149 Groups of standard form contracts could be issued in distributed ledger or block chain form, which could also allow for reinsurance cover and transfers to be dealt with on a digital basis.150 The European Commission published a Green Paper on financial services and insurance in December 2015.151

The U.S. insurance markets were considered to be ripe for disruption, and insurance has been referred to as the next frontier for FinTech.152 Very little has changed in the U.S. insurance area for some time, apart from the enactment of the Patient Protection and Affordable Care Act (PPACA) in 2010, which sought to increase the quality and affordability of health insurance within the U.S. healthcare system and was based on the Medicare and Medicaid programs that were established in 1965.153 Total net premia in the United States were in excess of $1.2 trillion annually.154 It was expected

145. Id.
146. ERNST & YOUNG, supra note 17, at 23, note 6, fig.7.
149. See id.
150. See id.
154. Dickinson, supra note 152.
that new products would be launched in the insurance area for the new economy, substantial improvements would be made in data provision and analysis, and new means of managing risks and providing capital with new structures for acquiring companies would be developed.\textsuperscript{155} Important new companies in this area include Oscar, Metromile, SURE, and PolicyGenius.\textsuperscript{156}

F. Operations, Risk Management, and Data Analysis

Substantial advances are expected in the areas of machine learning and cognitive computing, with systems learning and developing original tasks through new algorithms. Cognitive computing uses machine learning algorithms to simulate human thought processes.\textsuperscript{157} Big Data analytics involves the processing of the large volume of information stored by computers on the Internet, and new businesses are developing as a result of these information-gathering exercises.\textsuperscript{158} This includes data-centric computing, data management, and the development of new application programming interfaces (APIs). Digital and mobile payments systems bring forth the “consumerization” of technology, with new FinTech operators focusing on customer appetite and experience.\textsuperscript{159}

G. Interface and Digital Platforms

Many new FinTech companies only operate as new interface devices that place themselves between traditional financial customers and incumbent financial institutions. The new platforms are simply intermediate interfaces, or “veneers,” that attract customers through their novelty, branding, or topical design. Many of the companies are not authorized to engage in financial businesses with all of the traditional account and other trading work carried out through existing institutions. While this creates a sort of parasitic relationship, this can benefit both the start-up and incumbents, as evidenced by the new U.K. Internet-only bank Tide. Designed principally for small businesses using the latest technology, Tide was able to obtain $2 million in seed funding. But, Tide's core banking is undertaken through Barclays.\textsuperscript{160}

\textsuperscript{155} Id.
\textsuperscript{156} Id.
\textsuperscript{157} Walport, supra note 23, at 19 (suggesting that artificial intelligence is expected to develop through the stages of assistance (where computers absorb massive amounts of domain knowledge), understanding (deciphering), decisioning (the provision of semi-autonomous unbiased advice), and discovery (with the provision of new insight and new value)).
\textsuperscript{159} Id. at 19-21.
\textsuperscript{160} Id.
H. Government Services

FinTech could have a significant impact on government operations and services. The U.K. government commissioned a report to investigate the potential of distributed ledger technology. The report produced eight recommendations to promote and support the development of digital register systems within the United Kingdom. These were principally based on leadership and capability, investment, demonstrator development, optimum regulation, integrity, security and privacy standards production, identification and authentication protocol construction, application trials, and capacity and skills promotion.

Distributed ledgers can be used to assist government service provision through reduced operational costs, greater transparency, improved financial inclusion, increased data protection, critical infrastructure protection, reduced market friction, and the promotion of more general innovation and economic growth. This could be used to manage payments by HM Treasury (HMT) and the Department for Work and Pensions (DWP), including uses in connection with tax collection and welfare support delivery. This could reduce fraud and error, ensure financial inclusion, manage provision and ensure efficient operation.

Distributed ledgers could also be used to develop new types of information marketplace by removing market friction and promoting innovation, especially for small and medium sized enterprises (SMEs) using smart contracts and new asset registers or “smart assets.” Distributed ledgers could have substantial benefits in terms of managing micropayments, decentralized exchange, token earning, and spending and transfers not possible on the existing world wide web. Distributed ledgers could assist strengthen international aid provision, particularly through the production of new digital coins with double spending avoided and expenditure managed.

VI. Distributed Ledgers

The development of distributed ledgers has been one of the key technological developments in the FinTech area. A distributed ledger
consists of an electronic record or database within which items are stored in a continuous chronological order with copies being held across multiple sites, institutions and countries.168 A block chain can constitute a more specific type of distributed ledger in which items are collected in blocks and then linked or chained together.169 While distributed ledgers and block chains are only record or information management systems, they hold a new significance in the world of FinTech because they are governed by a specific set of common rules or operating protocols that determine the operation.170 Specific transactions can also be programmed within the ledger or block chain to operate in accordance with their own particular rules, or business logic, which creates smart contracts.171

Debt record systems date from ancient Mesopotamia with the use of clay tablets around 5000 years ago.172 Bank accounts constitute a simple form of payment record with banking dating back to ancient Mesopotamia.173 Bank accounts were also used in Greek and Roman times, such as the Greek *trapeza* and Roman *argentarii*.174 Sophisticated accounting systems were developed during the Renaissance period, especially with the Great Fairs in Italy and other northern European cities.175 Early payment instruments were developed with promissory notes used to create a debt by one party and bills of exchange to transfer payment obligations from one party to another.176 Promissory notes became most commonly used as private and then public bank notes in the city of London and elsewhere. Bank accounts gained importance again in London with the

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168. Similar components are identified in the U.K. GOVT OFFICE FOR SCI., supra note 37, at 17.
169. Id.
170. Id.
171. See id.
172. Debts were recorded in clay tablets, which were then stored in a clay ball, or bulla. These could also be held together on a length of cord or string. Simple early forms of correspondence accounting were developed with small hard clay objects being used to represent specific items with the number of objects representing the total number of items involved. The physical artefacts were then converted into notches on tablets with a simple system later developing for original or raw materials, such as agricultural produce, and more sophisticated notations for manufactured goods, such as bread or wine. The simplified notations later emerged to form counting systems with the more complex systems developing into hieroglyphics and then writing. See generally DENISE SCHMANDT-BESSERATE, BEFORE WRITING (Univ. of Texas Press, 1st ed. 1992); see generally DENISE SCHMANDT-BESSERAT, HOW WRITING CAME ABOUT (Univ. of Texas Press, 1st ed. 1996).
173. See generally BENJAMIN GEVA, THE PAYMENT ORDER OF ANTIQUITY AND THE MIDDLE AGES: A LEGAL HISTORY (Hart Publishing 2011) (stating that one of the first early banking families were the Egibi).
175. See id.
growth of goldsmith bankers around the 1640s with gold and silversmith receipts for deposited specie circulating as private banknotes. The use of electronic distributed ledgers would constitute a significant departure in this history of the record and payment systems.

A. LEDGER STRUCTURES

Different types of ledgers can be distinguished. These include determined or centralized registers, which would include, for example, land registers, other high asset value registers, or in the financial area, commercial bank reserve accounts held with the central bank. Decentralized registers include separate registers and distributed or shared registers. A separate or parallel ledger system would include, for example, bank accounts maintained by commercial banks for their customers with each bank holding a separate set of entries in a common format. A distributed ledger operates through the creation of distinct but identical multiple registers operating across the Internet without any single location. Each register is held at a node point within the system.

A shared ledger is a collective term for different types of multiple register systems. Shared ledger technology has been tested in a number of countries including the United Kingdom, United States, China, Singapore, and Latin America. This technology could be used to increase efficiency within the civil service, legislation and the oversight and management of the economy. The five countries of the United Kingdom, Estonia, Israel, New Zealand, and South Korea, form the “Digital 5” group of countries (D5) to promote research and exchange of information on the adoption of new digital technologies. The government in Estonia has carried out a number of large-scale tests using distributed ledger technology, in particular, through its Keyless Signature Infrastructure (KSI), which was developed by Guardtime. This allows individuals to confirm the integrity of the records

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178. Gov’t Office for Scl, supra note 37, at 36, fig. 2 (suggesting that ledgers can, for example, be classified as being centralized, decentralized, or distributed).
179. Id.
180. Id.
181. Id. at 18 (“The term shared ledger was developed by Richard Brown, formally at IBM and subsequently Chief Technology Officer of the Distributed Ledger Group, to refer to any database and application that was shared by an industry or private consortium or open to the public.”).
182. Id. at 26.
183. Id. at 26-29.
184. Id. at 7.
185. Id. at 6.
and avoids internal interference or manipulation. The KSI system supports Estonia’s e-Business Register and e-Tax system.  

A number of operational variants can be created within each type of register or ledger. Registers may be closed with some form of access or password protection or cryptography (permissioned), or open (non-permissioned). Closed systems will generally be based on proprietary software, while unrestricted access systems will generally use open source software freely available on the Internet. Registers may be owned by a single party or limited group or have no assigned ownership. Ledgers may generally operate on a controlled or consensus basis with control meaning subject to entry correction being carried out by a single party with consensus referring to different possible models for allowing entries across separate registers to be reconciled by more than one party. 

For the purposes of this paper, further distinctions can be drawn between denominated and non-denominated ledgers and static or active ledgers. Denomination is used to refer to accounting or record systems that measure value in terms of existing official currencies, such as the U.S. dollar or pound sterling. Non-denominated systems use new reference values, such as Bitcoin or other new forms of digital coin. Assets that are denominated in an official currency can be referred to as monetary assets, while other assets use a digital reference asset known as investment assets. Static systems record ownership to the specific asset concerned with active or dynamic systems, including an element of execution—such as payment—under a smart contract.

Reference may also be made to single, or unitary, ledgers and bi, or multi-chain, ledgers. Multi-chain ledgers consist of variants with separate functional sidechains that can be used for different purposes without increasing or decreasing the digital coin within the ledger. Ledgers may also potentially be connected or disconnected for different purposes. The

188. GOV’T OFFICE for SCI., supra note 37, at 17.
189. Id.
190. Payment may be made on a continuous basis such as with share dividends or bond interest payments. Payments may also be made in the event of a specific contingent event arising such as under an insurance policy or credit derivative contract.
191. See Tim Swanson, Blockchain 2.0 – Let a Thousand Chains Blossom, LTB NETWORK (Apr. 8, 2014), https://letstalkbitcoin.com/blockchain-2-0-let-a-thousand-chains-blossom. The article suggests that Sidechains have been developed as part of “Blockchain 2.0” for altering the core protocol. This would, for example, allow Bitcoin to be used as a transactional currency in connection with a number of other asset types in sidechains including shares, smart contracts, derivatives or other user assets. Consensus building and confirmation could also be extended to sidechains through a fee rather than additional coin reward system. See also Nicolas Courtois, Is Bitcoin Going to Split in Two?, WORDPRESS (2015), http://blog.bettercrypto.com/?p=1811 (commenting on the difficulties in securing agreement on using larger blocks, increasing transaction speed, lowering fees, and securing wider adoption of Bitcoin).
most common forms of future ledgers use different aspects of these various features.

B. Ledger Use and Application

Distributed ledgers are inherently low cost, and avoid duplication and inefficiencies in control and coordination through the use of an open common ledger without the need for continuing reconciliation. While manufacturing companies generally focus on product innovation and service companies on process innovation, digital technology can lead to more substantial effects in terms of business model innovation. One can even call the FinTech movement a “revolution,” as revolutions are generally associated with substantially lower costs, new communication channels, and adjusted infrastructure and logistics.

Title holdings in almost all assets can be digitalized and kept on distributed ledgers. This could be extended to include securities clearing, settlement, custody and registration services, smart contracts, and diamonds. Smart contracts could form the basis of a new “programmable economy,” based on decentralized networks and agents operating as distributed autonomous organizations. This could, for example, be used in the motor insurance area—with contracts containing both information on the condition of the driver and the car. Additional specific attribute information could be included, such as in digital currencies, only to allow them to be used for specific purposes.

C. Ledger Security and Privacy

The effectiveness of technology is dependent upon how it is designed, implemented, and governed—with systems being subject to external and

192. GOVT OFFICE FOR SCI., supra note 37, at 56-57.
193. Id. at 53.
194. Id. at 54.
195. A peer-to-peer securities transactions block chain has been developed by SETL in London. Post-trade administrative costs are estimated to be between sixty-five–eighty billion dollars, which could be saved using block chain technology. Id. at 58.
196. Codel is developing a block chain system, using digital notary software, to process corporate actions with an Instant Actions registry for corporate action data developed by Codel and industry participations. Corporate actions concern the processing of company announcements through data vendors and custodian and fund manager intermediaries. Global costs are estimated to be around ten billion dollars per year. Id. at 58-59.
197. Ethereum has been developing a decentralized platform for the processing of smart contracts. Id. at 57.
198. Everledger has developed a block chain technology and digital passport system to record the provenance and transfer of diamonds using a cryptographic fingerprint. GOVT OFFICE FOR SCI., supra note 37, at 56.
199. Id. at 57.
200. Id.
201. Id.
internal attacks, and component failure. Security systems are generally based on specificity, resilience, and robustness. The theoretical advantage of distributed systems is that they operate on a decentralized and consensus basis, without any single or central point of trust or failure. Cryptography prevents the abuse of private and public keys, while complex consensus protocols manage reconciliation.

Further issues arise regarding privacy. Bitcoin was described as an anonymous system in the original 2008 paper, although it is possibly better considered pseudonymous with substitute names being used. An unlimited number of wallets can be held in unconfirmed names, with no identification or money laundering requirements applied. This is explained in terms of a matter of design choice for Bitcoin, which may otherwise have limited its use at the same time by undermining the fungibility of Bitcoin as a currency. This pseudonymity is nevertheless restricted because wallet owners can be identified, and all relevant transactions then become visible on the publically transparent block chain.

Digital currency payments can be more transparent than traditional online transactions, where identities are only revealed between parties. Additional privacy can be provided through various techniques, including addresses and wallets, to prevent individual identification, or through the use of group signature algorithms that confirm that coins are held, although not the specific coins which breaks the link between current and previous transactions.

D. Ledger Governance and Regulation

Distributed ledgers are managed by legal rules and regulations, and technical and computer code. Technical code includes both software and protocols. The modern financial system can already be considered substantially digitalized and operates on the basis of internal technical program, especially in terms of record creation and amendment. External

202. Id. at 47.
203. Id. at 48.
204. GOV'T OFFICE FOR SCI., supra note 37, at 47.
205. Id.
206. See, e.g., S. Meiklejohn et al., A Fistful of Bitcoins: Characterizing Payments Among Men with No Names para. 9 (2013).
207. GOV'T OFFICE FOR SCI., supra note 37, at 50.
208. Id. at 50.
209. Id.
210. Id.
211. This is used in Zerocoin, Zerocash, Pinocchio Coin, and other Sigma protocols. Id. at 51.
213. Computer software consists of internal machine language and higher-level programming language instructions, which determine how the computer operates as distinct from computer hardware. Computer protocols determine how computers connect with each other. See, e.g., GOV'T OFFICE FOR SCI., supra note 37, at 41.
214. Id.
regulation is then applied to manage the risks produced by internal code activity. Governance can be distinguished from regulation—with governance referring to internal decision-making processes.

Distributed ledgers benefit from low compliance costs, as they are controlled by technical rather than legal code. Market bodies can develop separate sets of standards to govern the operation of particular systems, such as with the Visa Core Rules produced by Visa Inc. Technical codes also have to be maintained and revised over time. Difficulties have, nevertheless, arisen with the private governance arrangements surrounding Bitcoin with differences of opinion having arisen as to the future development of the code and with no resolution having yet been achieved. Some parties wish to revise the code, for example, to operate faster with larger header blocks and other revisions, while others wish to remain with the original code.

Permissioned ledger systems can be more directly controlled, as they generally operate under the auspices of a particular owner or group of proprietors. Unpermissioned ledgers have only been directly controlled to date through the imposition of regulatory obligations on authorized institutions that deal with ledger operators or digital coins. This can also be extended to service operators such as exchangers or wallet providers. The New York State Department of Financial Services required businesses providing digital currency services to New York residents to be licensed with a BitLicense in August 2015. Digital currencies can also be made subject to specific, developed technical codes using public funds, and without any direct public direction. Internet and World Wide Web protocols have, for example, been developed by the international non-profit organization, the Internet Society. This could then be applied with regard to both permissioned and unpermissioned systems, with a split or multi-governance level approach being developed for FinTech regulation.

E. INTERNATIONAL LEDGER DEVELOPMENT

Distributed ledger technology can be used both to assist domestic companies’ growth internationally, and for countries to construct larger digital economies that can support trade growth and expansion. Block chains could also be used to distribute foreign aid payments. A number of countries along with the EU have adopted specific digital economy

215. Id.
216. The Chief Scientific Adviser refers to this in terms of private rulemaking governance. Separate individual micro and wider macro systems external regulation is then applied. Id. at 42.
217. Id. at 80.
218. Id. at 44.
219. Id.
221. GOV’T OFFICE FOR SCI., supra note 37, at 44-45.
222. Id. at 49.
Digital economies can aim to secure speed, reach, and efficiency. Successful digital economies are based on a necessary degree of trust, including identification and verification, and interoperability, with data and policy interoperability and effective collaborative implementation of relevant standards. Trust within digital economies is dependent on securing a necessary degree of internationally defined level of assurance (LoA) and multiple agency authentications through Federated Identity Management (FIM). A significant amount of work is being carried out in each of these areas.

VII. Digital Currencies

Distributed ledger technology has attracted particular attention recently in connection with its use in digital currencies, specifically Bitcoin. Nevertheless, this only represents one possible application of ledger models. A number of other digital currencies have also been created in addition to Bitcoin that operate on a similar basis, although with variation.

The following further points may be made with regard to block chain technology in the currency area.

A. Digital Establishment and Objectives

Digital currencies, such as Bitcoin, operate as a peer-to-peer payment system for the transfer of electronic cash. A programmer named Satoshi Nakamoto created Bitcoin in 2008. In 2009, the software was made available on an open source basis, and a nine-page paper published in October 2008. The identity of Nakamoto has remained unclear despite a number of unsubstantiated attempts to name the originator or claims to

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223. Id. at 78.
224. Id. at 77.
225. Id.
226. Id. at 74.
227. GOV’T OFFICE FOR SCI., supra note 37, at 74.
authorship.229 The amount of coding directly carried out by Nakamoto was nevertheless limited.230

The original Nakamoto paper refers to the need to avoid having to use a trusted third party as an intermediary in order to avoid double spending in any cash system—prevented through the use of a peer-to-peer network and times tamped transactions. This is carried out by hashing, or converting the transactions into a fixed string of characters, and recording them on an ongoing chain of proof-of-work, which creates a record that cannot be amended without correcting all of the previous proof-of-work.231 Proof-of-work is a form of participation condition that is difficult to solve but easy to verify. The longest chain within the block acts as proof of the sequence of earlier transactions and proof that this was generated on a consensus basis by the verification miners with the largest pool of computer power.232

Nakamoto notes that online commerce relies almost exclusively on financial institutions acting as trusted third parties to process electronic payments which trust can be replaced by cryptographic proof.233 Key parties are able to transact directly without the need for a trusted intermediary with transactions that are computationally impractical to reverse preventing double spending and fraud. The paper nevertheless accepts that the system is only secure as long as “honest nodes [computer terminals holding the complete block chain] collectively control more CPU power than any cooperating group or attacker nodes.”234 This is referred to as the 51 percent attack problem.235


230. Nakamoto was attributed with only having developed 2 percent of the total Bitcoin code before transferring responsibility to the Australian programmer, Gavin Andresen, and other programmers. Andresen was responsible for 6 percent with Jeff Garzik contributing five percent, Mike Hearn six percent, Vinnie Falco 12 percent, Wladimir J van der Laan 16 percent, and Pieter Wuille 22 percent. Gov’t OFFICE FOR SCI., supra note 37, at 43.

231. Nakamoto, supra note 228, abstract 1

232. Id.

233. Id. at 1.

234. Id.

235. The Bitcoin Develop Guide accepts that a 51 percent attack could be carried out against the transaction history if an operator was able to acquire a majority of the network’s hashing power. Id. at 1. An attack could also be carried out with even less than 50 percent of the hashing power. Bitcoin Developer Guide, BITCOIN, https://bitcoin.org/en/developer-guide#stratum (last visited Sept. 1, 2016).
The total number of bitcoins is fixed at 21 million to protect their value over time. These are released on a controlled basis with the final coins expected to be generated around 2040. Bitcoins can also be dealt with in subunits referred to as millibitcoins (10^{-3}), microbitcoins or bits (10^{-6}), or Satoshis (10^{-8}). Bitcoins can either be referred to as XBT, which conforms to ISO 4217, or BTC, which is not officially recognized. Nakamoto defined “an electronic coin as a chain of digital signatures.”

B. DIGITAL OPERATIONS

Bitcoins are described as being stored in wallets that are privately held. Coins are not actually stored in the wallets, but rather, move through transactions across a block chain. Rather than hold coins directly, wallets store the private digital credentials necessary to transfer coins. Wallets are separately loaded onto private computers using open-source software. Transfers are carried out through transactions using unspent outputs from previous transactions.

The first of each set of transactions in a block is referred to as the coin base or generation transaction, which uses the block reward coins. Coins are transferred by digitally signing a hash of the previous transaction and the public key of the next owner is then added to the end of the coin. This allows payees to “verify the signatures to verify the chain of ownership.” Double spending is prevented through the use of a timestamp server, which publicly discloses each timestamp, including the previous timestamp, to create a chain. Each block also produces a nonce, which is a random number that can be used to attempt to calculate the correct hash for a specific block.

The network operates with new transactions being broadcast to all nodes, and with nodes collecting new transactions into blocks. Each node calculates the proof-of-work for the block and broadcasts this to all other nodes. All full nodes validate blocks using the same consensus rules. Other nodes only accept the proof-of-work if all transactions are valid and not already spent. This is accepted by creating the next block in the chain

238. Nakamoto, supra note 228, at 2.
240. Davis, supra note 229.
241. Id.
244. Id.
using the hash of the last accepted block. Duplication and double-spending are prevented with nodes working on the first chain received, therefore reserving any other notified chains. The correct chain is then confirmed when the proof-of-work is confirmed and the correct chain identified.

C. **Digital Cryptography**

Bitcoin uses a combination of private and public cryptographic keys. Private keys are always kept confidential within an individual’s wallet. Bitcoin uses an Elliptic Curve Digital Signature Algorithm (ECDSA). The private key will be a randomly generated number expressed as a single unsigned 256-bit integer (thirty-two bytes). The public key is used to confirm that signatures are genuine and are based on the private key, although the private key cannot be determined from the public key. Signatures confirm signing, which is mathematically generated from the hash of the transaction, and the private key. Signatures are either seventy-three, seventy-two, or seventy-one bytes long.

D. **Digital Mining**

An anonymous peer-to-peer verification system is created through the use of miners, which are independent, powerful central processing units. Miners receive new coins upon the creation of each new block, as well as transaction fees for the transactions carried out within the block. Mining can be conducted on an individual basis using powerful processing devices, although, in practice, most mining operations are conducted using stacks of large numbers of processors together, which are often based in less developed countries due to the cheap cost of electricity. Many of the largest mining operations are organized into pools or guilds.

Mining computers carry out their proof-of-work by randomly attempting to match the block hash; the apparent number of total combinations is around 1 to 250 trillion. Every time a specific mining computer selects the correct hash, it is distributed across the other nodes for confirmation. The correct solution receives a twenty-five bitcoin reward, which will eventually be replaced by a fee system once all of the bitcoins have been

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245. *Id.*
issuеd.252 The system is controlled to allow each block to be resolved around every ten minutes.253

E. DIGITAL ADVANTAGE AND DISADVANTAGE

Bitcoin is claimed to create a fast, secure, and efficient money generation and payment system. The system is, nevertheless, arguably too complex, with over 380,000 blocks already generated and held within a forty-five gigabyte ledger.254 The system is also slow and only allows for two transactions per second as compared to Visa allowing over 1,736 transactions per second.255 Additionally, the blocks are too small in size and only contain around 140,000 transactions each.256 Substantial delays can occur in using transferred coins, with payees having to wait up to one hour.257 Further, historically, the value of a bitcoin has fluctuated widely.258

Mining involves a massive waste of energy of around forty terawatts a year. This also represents a significant amount of computational waste that could be used for other purposes.259 The system lacks transparency in terms of adjustment, and there appears to be a lack of effective governance and oversight, with disputes arising regarding amendment and revision. It is accepted that the network is theoretically subject to a 51 percent attack, if not less.260

The highly technical nature of the software used also creates substantial technological dependence. Bitcoins are generally not accepted as currencies, and therefore deposit protection or other central bank lenders of last resort do not support transactions. The ability to use unspent coins also requires that private wallets are protected, with coins being irrevocably lost if the wallet is lost or damaged. Substantial difficulties also arise with regard to controlling the volume and price of money as part of central bank monetary operations.

252. Id.
253. The solution speeds are controlled by adjusting the difficulty value in the consensus protocol. The network calculates the number of seconds for the generation of 2,016 blocks with the difficulty value being adjusted to ensure that they are produced around every two weeks (1,209,600 seconds). Bitcoin Developer Guide, supra note 235.
255. The Magic of Mining, supra note 254.
256. Id.
257. This occurs as one of the mining pools was able to receive two lots of coin successively with users having to wait up to 6 times10 minutes, or one hour, before the transactions are confirmed. Id.
258. The value of Bitcoin peaked in April 2013 at $266 and rose to a high of $1240 (£914) in December 2013 before falling to $339 (£245) in April 2014. ECB, supra note 53, at 26.
259. Id.
260. The Trust Machine, supra note 254.
VIII. FinTech Advantage

The arrival of FinTech has been heralded as generating a number of important advantages and disadvantages. The advantages and disadvantages will have a significant impact on the development of banking and financial products, and services, especially as FinTech brings together financial, technological, and social media advances. All of advantages and disadvantages have to be properly identified to fully understand FinTech market development.

The principal advantages can be summarized in terms of increased access, quality, speed of service at lower cost and with greater control, and additional security, depending upon the specific cryptographic function and options adopted. While this will have a disruptive effect on incumbent business models, to a significant extent, this simply brings forward necessary change and reform that will make banking and financial markets more efficient, competitive, and innovative over time. Although there may be some immediate employment loss, FinTech will create new opportunities, while at the same time forcing improvement in relevant educational and training standards. This can lead to improved growth, earnings, taxation receipts, and overall welfare and social benefits.

The advantages of FinTech may be considered more specifically under the headings that follow.

A. Technology

A number of inherent advantages arise as a result of the new technology used in the FinTech area. The IMF noted that these technologies are driving transformational changes in the global economy, including home goods, services, and asset exchange.\(^261\) Distributed ledgers and block chains can provide specific benefits in terms of cryptographic reconciliation, replication, granular (individual or component level) access control, transparency, and privacy.\(^262\) Specific advantages are identified in the headings that follow.

1. Speed and Capacity

New digital systems can be considerably faster than earlier electronic analog or physical processing models, and have considerably greater capacity. This is principally generated through the use of microprocessors, which have become substantially smaller in size in recent decades due to

\(^{261}\) Int’l Monetary Fund [IMF], Virtual Currencies and Beyond: Initial Considerations, at 5 (Jan. 20, 2016).

\(^{262}\) GOV’T OFFICE FOR SCI., supra note 37, at 22.
Moore’s law, which refers to the doubling of the number of components in an integrated circuit every year.263

2. Cost and Efficiency

New systems can be manufactured at considerably lower costs, which makes their use substantially more efficient in relation to income generation and profit.

3. Security and Confidence

New technology can benefit from substantial improvements in security, which, in turn, promotes user trust and confidence.264 This may be of particular importance, following the global financial crisis and mistrust in traditional financial markets, with many people placing more reliance on cold technology, rather than pilloried intermediaries.

4. Digitalization and Durability

A number of specific advantages arise as a result of the digitalization process itself.265 This allows continued accuracy, perfect copying, efficient amplification, replication, consequent scalability, and overall improved durability. Digital replication of ledgers avoids the need to manually update multiple registers within a single institution, across companies, or government departments.266

5. Transferability, Expansion and Evolution

Many specific types of digital products are easily transferable, including digital coins and dematerialized securities. A number of further benefits may arise directly from the use of the new technology used, such as machine learning and cognitive computing; block chain and digital currencies; Big Data analytics, optimization and fusion; distributed systems, mobile payments, and peer-to-peer applications; and in-memory computer capability, data clouds, and service technology.267


264. Society for Worldwide Interbank Financial Telecommunication (SWIFT) and Accenture refer to distributed ledgers’ core advantages in terms of trust in a disseminated system, efficiency in broadcasting information, complete traceability of transactions, simplified reconciliation and high resiliency. SWIFT and Accenture, SWIFT on Distributed Ledger Technologies, 3 (Apr. 20, 2016), http://www.ameda.org.eg/files/SWIFT_DLTs_position_paper_FINAL1804.pdf.

265. ERNST & YOUNG, supra note 17, at 2.

266. GOV’T OFFICE FOR SCL, supra note 37, at 21-22.

B. BUSINESS MODELS

The establishment of large numbers of new FinTech start-up companies and the adoption of FinTech changes within incumbents will lead to significant changes in business practices and models. New technologies can have a major impact on business operations, including developing innovative new products and services; generating alternative management models and additional revenue streams; producing lower cost operations; and streamlining organizational structures. While the term disruption may appear critical and negative, it can also be considered simply to refer to the need for change, reform, and the bringing forward of innovation and evolution within natural or evolutionary business cycles.

1. Growth and Efficiency

Financial technology solutions may generate substantial new income-generating capabilities at significantly lower costs, which will improve earnings and overall efficiency.

2. Competition

Competition will be substantially increased by new start-ups competing with incumbents, and by incumbents competing with each other to develop the most efficient and profitable FinTech solutions. Many official bodies have promoted this as a key objective. The Competition and Markets Authority (CMA) in the United Kingdom recently published a paper on the supply of personal current accounts (PCAs) and banking to small and medium-sized enterprises (SMEs). The paper includes a recommendation that the major UK banking groups develop common electronic data exchange standards to allow the creation of an “Open Banking” marketplace, within which customers are able to transfer the accounts between institutions easily through mobile applications.

268. Gov’t Office for Sci., supra note 37, at 53.
269. COMPETITION & MKTS. AUTH. [CMA], RETAIL BANKING MARKET INVESTIGATION: FINAL REPORT, at para. 1 (Aug. 9, 2016).
270. The earlier Independent Commission on Banking (ICB) promoted the creation of a current account redirection service to allow the switching of current accounts for individuals and small businesses, in addition to its core recommendation of structural regulation and the fencing retail and SME banking from investment banking. INDEP. COMM’N ON BANKING [ICB], FINAL REPORT: RECOMMENDATIONS, ch. 8 (Sept. 2011).
3. Innovation

External and internal FinTech development will substantially increase the amount, quality, and depth of innovative change in financial product design and service provision.

4. Open Access and Cloud Services

The nature and operation of many parts of the banking and financial system will substantially change with the adoption of new practices as systems move from pre-FinTech to post-FinTech conditions. There will be substantial conversion and transformation of business structure, product designs, and service provision.

Cloud servicing and computing is expected to receive additional substantial growth, as smaller start-ups have to rely on shared resources initially, while new digital platforms also operate on a collaborative basis.271 Incumbent systems may also be increasingly open and operate on a shared rather than closed basis. The Financial Conduct Authority (FCA) in the United Kingdom supports the possibility for financial institutions to use cloud storage facilities and it issued guidance in 2015.272 The UK challenger bank, OakNorth, transferred its core systems to Amazon’s Web Services in 2016.273

5. Business Support

A number of new innovative project development models have already been created to promote innovation, change, and support FinTech development. These include digital Incubators, Accelerators, Factories, and Laboratory and Catapult services in the United Kingdom and elsewhere, which provide a wide range of funding, continuing support, and mentoring. Substantial amounts of capital are also provided through specialist firms, including venture capital funds, such as Lightbank274 or possibly individual angel investors, who invest in firms directly, rather than through managed funds.

271. Cloud computing involves the provision of scalable and elastic IT capabilities using Internet technologies with the most common form being referred to as Infrastructure as a Service (IaaS).
273. Emma Dunkley, OakNorth Takes UK Banking into the Cloud, FINANCIAL TIMES (May 26, 2016, 12:05AM), https://www.ft.com/content/36c4eba2-2280-11e6-9d4d-c11776a5124d.
C. Users and Stakeholders

FinTech evolution will lead to substantial change and benefits for users and other stakeholders.

1. Choice and Quality

Banking and financial customers will receive substantial benefits regarding the access to and quality of service provided, especially on a mobile basis through new applications and digital platforms. Start-ups and incumbents will both have to focus on customer service quality, support, and satisfaction in order to build and protect market share. This shift of attention from firm to customer focus reflects the wider changes in the demand for new ethical approaches to be adopted by financial institutions following the global financial crisis. The natural adoption of FinTech solutions may have more of an impact in this area than other forced ethical changes.

2. Access and Inclusion

The use of mobile access channels and, in particular, digitally based applications will allow customers to choose from a wider range of services and service providers. New application interfaces (APIs) will also increasingly allow customers to move from one service and platform to another, which will again increase the overall depth and quality of service provided at the same time as increasing competition.

3. Work and Employment

While some employment positions may inevitably be lost with the adoption of new forms of technology, large numbers of new opportunities will also become available, either in setting up and designing new FinTech companies and programs, or in managing FinTech services within new operations and incumbents.

4. Education and Human Capital

The evolution of the market will also lead to substantial change in education and training, with a number of government and official initiatives already adopted to improve standards in this area. This should also lead to the creation of an even larger specialized, and highly qualified workforce in this area that will continue to grow as firms and service providers compete within Europe and globally.

5. Government and Central Banking Operations

The government has clearly indicated its willingness to use digital solutions to improve the nature of its operations and interaction with the public. FinTech options could substantially improve the quality and cost of many government operations and services. The government will act as an
“expert customer” in this area, which will support FinTech development further. Many central banks are also looking at FinTech opportunities to support, or partially replace, some of their own operations, subject to careful oversight and control.

D. GLOBALIZATION

FinTech growth will further support the development of borderless online virtual markets and, with this, globalization more generally. Growth in physical trade and services will be paralleled by growth in the online exchange of goods and services. This can specifically benefit many of the principal financial centers, including the City of London, as well as support wider regional, and, in particular, European, international, and World Trade Organization (WTO) integration initiatives.

1. Trade in Goods and Services

The physical purchase, sale, and movement of goods and provision of services on a cross-border basis will continue under existing international trade and WTO arrangements. There has already been a substantial growth in globalization over recent decades although further progress has hesitated following impasses in post-Doha Round negotiations, especially in the more protected conditions that have applied following the global financial crisis. Growth in trade and services may nevertheless receive separate stimulus through FinTech expansion with new solutions being made available to locate and source goods and services and in the creation of more sophisticated supply chains. This may also be supported by the larger growth and expansion of Internet based exchange and the move towards the Value Net as the next phase of Internet development. FinTech could have a substantial impact in bringing customers and goods and service providers closer together.

2. Payment, Liquidity, and Capital Mobility

FinTech companies and solutions have already confirmed their ability to improve cross-border payment and foreign exchange. This could, in turn, lead to further increases in liquidity provision and capital mobility. Total global wealth will not be diminished, and will potentially increase, with FinTech, as investors and wealth managers move financial and monetary


assets around in order to benefit from the new investment opportunities available. 278

3. International Financial Center Growth

FinTech growth may specifically benefit the expansion of many of the existing leading international financial centers. While specific markets may contract in the face of FinTech based change, the liquidity and capital involved can be transferred to other FinTech driven market options and opportunities. The City of London may specifically be able to benefit substantially if the United Kingdom can continue to act as a major player in international FinTech development. This may affect all of the key financial sectors including savings, lending, payment, investment, and insurance and risk management.

4. EU and Regional Integration

The European Commission has indicated its strong commitment to the development of a European Digital Market, which will include a significant FinTech element. Mutual recognition and the creation of legally enforceable cross-border access rights can support FinTech companies within Europe and act as a model for further regional and international expansion of the sector. The European model is based on the mutual recognition of access rights, minimum harmonization of relevant regulatory standards, and the fundamental allocatory principle of home country control. 279 These could be reapplied as governing principles within any new digital and FinTech operational framework or architecture. Care only has to be taken to ensure that unnecessary restrictions and obstructions are not imposed on FinTech services in a disproportionate and distortionary manner, which will only limit innovation and competition within the EU and between the EU and the rest of the world.

5. Global Integration and the WTO

FinTech solutions can be used to support international trade in goods and services more generally, specifically locating and paying for desired items, and obtaining credit, liquidity, and investment support. FinTech may then support continued growth of the international mercantile economy and of development finance. 280 The growth of FinTech will also support the continued expansion and strengthening of the online Internet digital trading system through the purchase of digital only assets, such as news,
information, and media, or access to social communities, without any physical element. FinTech can accordingly support growth in both the traditional mercantile and the new virtual or digital global economies. The development of new global treaty solutions may be further stimulated by the decision under the UK referendum to leave the European Union on June 23, 2016, after entering into many new bilateral and international treaties on a mutual recognition and equivalence basis of all without the same underlying mandatory treaty access rights and supporting complex institutional structure.

E. Governance and Regulation

FinTech could allow substantial improvements in the quality and content of internal firm risk identification, measurement, and management, as well as external market regulation, supervision, and wider oversight. Technology can be used both to assist risk management and control within financial institutions and the supervision of firms by the authorities and wider market and systems oversight.

1. Authorization

Regulatory obligations can be tailored to more precisely match specific risks by setting calibrations much more accurately to capture the particular risks involved, providing the necessary cover either in terms of capital or liquidity, and limiting debt or leverage levels. A number of new reporting obligations have been imposed on banks, securities firms, and insurance companies under recent major international and European measures including Basel III, CRD IV, MiFID II and Solvency II. FinTech could allow a more specific set of relevant, necessary, and accurate requirements to be imposed.

2. Compliance

FinTech systems allow financial firms to comply automatically with new reporting requirements, as well as with any trigger ratios being monitored and signalled in the new compliance systems set up. FinTech can assist both with measurement and identification of risk, with wider risk management. FinTech facilities may also allow for the automatic adjustment of positions, especially with regard to liquidity, capital, and leverage levels, as necessary. Compliance could become considerably more automated, automatic, and autonomous.

3. **Supervision**

Supervision by authorities would become correspondingly more efficient with the more accurate reporting of data by firms in near real time. Necessary analytical systems can be developed within authorities to map data reports and highlight any concerns. With compliance, supervision would move from being static and retrospective or retroactive, with possibly considerable delays, to becoming more precise, accurate, and effective with almost real time monitoring and collection.

4. **Connections and Networks**

Authorities will have to extend the scope of their supervision to cover increasingly complex delivery chains and connections between service providers within all financial sectors. This will involve monitoring all of the specific operational relations that firms maintain. This may require substantial improvement in the quality of supervision and the creation of a form of new “MicroTech” supervisory procedures and standards to support this work.

5. **Systems Oversight**

In addition to being aware of connections at the firm level, authorities will have to monitor increasingly extended inter-firm relations and wider systems and systemic threats. The new forms of macro-prudential oversight are currently under construction in many of the principal financial centers, including with the Financial Stability Oversight Council (FSOC) in the United States, European Systemic Risk Board (ESRB) in the EU, and Financial Policy Committee (FPC) in the United Kingdom, will have to be extended to create a new form of “MacroTech” oversight. This will require specialist expertise with macro-prudential agents and increased cooperation between micro and macro-monitoring authorities.

**IX. FinTech Disadvantage**

Corresponding ranges of potential areas of concern or disadvantage have to be considered with the move to FinTech driven financial services, markets, and systems. A range of new and more specific technology risks, referred to as “TechRisk,” and wider FinTech systems, “FinRisk,” will have to be considered while FinTech effects may also increase other existing primary and ancillary risks.

The principal difficulty that will arise with FinTech is the fragmentation of function and dislocation of service delivery, which will also become necessarily online and virtual. Many of the new exposures can be considered to constitute a form of extended operational risk, which, in itself, creates wider systems effects and exposures. Five specific areas of concern may be identified with: technology risk, complexity risk, network risk, systems contagion and emergence risk, and supervisory omission risk.
Technology risk can be considered to involve a range of more specific operational risks, which can be classified in different ways and would include program error, model error, and connection error. Complexity risk will arise in that FinTech systems will become considerably more sophisticated and extended. Separate network risk arises with the increasingly complex nature of the connections that will arise between separate systems and platforms in larger extended chained arrangements.

The high degrees of interconnection and transmission speeds will also make contagion a much more serious threat with the further complication of complex systems being inherently emergent and susceptible to multiple levels of dynamic chain effects. Complex causation and emergence can substantially decrease predictability and increase uncertainty. Omission error may arise when authorities have inadequate powers and tools necessary to identify and respond to the new exposures that may arise. While this is an aspect of perimeter review, it also involves having the necessary tools available to respond to the exposures that arise.

A number of corresponding difficulties will then arise in the FinTech arena that will have to be balanced against the benefits referred to. These may generally be summarized in terms of possible technology default and dependence; business disruption; customer and stakeholder damage; unforeseen or uncontrollable international competitive effects; considerably more complex regulatory and supervisory demands; infrastructure; and possibly significant threats to the conduct of traditional monetary policy and financial stability in general.

These FinTech limitations may be considered in further detail.

A. Technology

As FinTech is technology driven, the effectiveness of specific new FinTech products and services will be dependent on the error-free nature of the FinTech solution involved. A number of specific difficulties may arise with regard to operations, complexity, integrity, efficiency, and dependence.

1. Relative Speed and Size

The value of any new technology will largely depend on its speed and size of the processable amount of information involved. Design decisions also have to be taken with regard to the size of new digital blocks, with larger sizes possibly increasing complexity and reducing processing speeds.

282. See IMF, supra note 52, at paras. 31-64. The IMF examines potential FinTech disadvantage in terms of regulatory challenges, financial integrity, consumer protection, taxation, exchange controls and capital flow management, financial stability, and monetary policy. Id. The IMF developed five principles in terms of future regulatory response. Id. at paras. 32-37. The IMF stated that more could be undertaken at the international level to develop an effective framework for new currency regulations with standards and best practices being developed over time. Id. at para. 37. The evolution of the market and changing policy challenges created had to be monitored and examined over time.
2. Cost, Complexity and Competence

Digital programs are inevitably considered more complex than earlier simple paper and analogue electronic double-entry bookkeeping accounts. This complexity necessarily increases initial design and production costs, although subsequent replications may be cheap and cost effective. Complexity, nevertheless, requires specialist training for operators while also making maintenance, correction, and revision more difficult and costly. Many financial firms will increasingly and disproportionately become dependent on a small group of specialist technicians, without whom they would not be able to maintain all of their connected processing systems. Separate issues arise with regard to the ability of algorithms and programs to carry out sophisticated decision-making in the financial area, such as with regard to peer-to-peer lending and insurance assessments.283

3. Security and Integrity

Internet-based systems necessarily create substantial additional risk of attack and interference. Many systems use cryptographic devices to improve security, although these necessarily further increase complexity and cost. Even with Bitcoin, it is theoretically subject to a 51 percent attack if 51 percent of the computer systems used by miners become manipulated by a single program. It has to be accepted at the present time that no digital system is fully secure. The degree of relative security would also be proportionately reduced in open access, or permissionless, systems, such as Bitcoin, as opposed to other controlled access, or permissioned, systems.

Possible technology error and security issues also necessarily raise additional concerns with regard to systems and data integrity. The accuracy and validity of specific inputs may be undermined even without full systems attacks or failure. Additional problems also arise with regard to maintaining backup systems and continuity planning. This can become a difficult and costly issue for any large institution, or smaller institutions that are data dependent. Related legal issues also arise in being able to evidence and maintain authoritative and unchallengeable entry records of entitlements for official registers and judicial proceedings, as well as in protecting personal data storage, accuracy, and access.

4. Efficiency and Waste

While modern digital systems may be exceptionally fast, they may also involve substantial waste depending upon the model or arrangements used. Validation within Bitcoin relies on the separate processing capability

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283. See Naomi Rovnick, City Grandee Lord Turner Warns on Peer-To-Peer Lending Risks, FINANCIAL TIMES (Feb. 10, 2016, 10:41 AM), http://www.ft.com/cms/s/0/e123234c-c564-11e5-92a1-c5e23c599c77.html#axzz4J2dch0mi. Lord Adair Turner, former CEO of the Financial Services Authority (FSA), has warned of potential substantial losses in the peer-to-peer lending market as a result of pure credit assessment quality. Id.
maintained by mining computing. This involves substantial energy usage and waste, with the system also being dependent on external third parties over whom operators, users, and authorities have no direct control. This creates substantial concerns at times of reduced energy use and environmental protection, while a system’s integrity is also undermined by the reliance on external third party exposure.

5. Dependence and Substitution

Many FinTech systems may become wholly reliant on technology. Wider systems would be subject to technological dependence as FinTech use expanded. Separate problems with substitution would arise where FinTech devices were allowed to take over more traditional financial instruments or whole areas or sectors. In the event of a FinTech device failure, it may not be possible to return to any previous simple paper or other electronic option. The financial system and society would then be subject to both technological dependence and have no effective substitution or replacement. This could create significant difficulties in the event of, for example, the failure of a large firm, platform, dominant private digital currency, or uncertificated security asset.

B. Business Disruption

Distributed ledger technologies have the potential to disrupt economies and societies. FinTech will necessarily impose a degree of business disruption, depending upon the extent to which and speed with which it grows and expands. This will necessarily affect incumbent business structures, the availability of many business models, the nature and extent of possible extended business relations, competition, and overall innovation.

1. Business Model Displacement

Many existing core financial services may be subject to substantial disruption with new market entrants or the application of new systems to existing practices. This has to be welcomed to the extent that it brings forward necessary updating and business chain or cycle revision, although care has to be taken to ensure that this does not become economically and socially disruptive. Much of this will depend, in practice, upon the extent to which authorities permit or restrict new FinTech companies and devices to enter incumbent markets and grow. Particular problems may arise if the effects and the impact of uncontrolled FinTech advancements are not
monitored and managed effectively in sensitive areas. While competition authorities promote competition, the wider impact of widespread economic and social disruption also has to be monitored. This is an area in which the government will have to assume lead role and responsibility.

2. Extended Model Management

Many existing business models will have to be updated and revised substantially, while others may become inoperable in light of the effects of new FinTech use. This will also lead to the development of extended links and complex product supply chains. This can impact FinTech start-up companies, existing incumbent financial institutions, non-financial market entrants, and existing large manufacturing and service companies. Many areas of business and management study, strategy, and modelling may have to be substantially revised in light of the effects of FinTech impact.

3. Business Relations and Networks

FinTech will necessarily change the structure of many financial markets and sectors, especially with the influx of new start-up companies and FinTech growth companies. While some of these companies may, at least, initially attempt to compete with incumbents, over time many may operate on an agency or outsourcing basis, sell their technology to existing firms, or have their companies acquired by incumbents. Significant dislocation of function could necessarily create a fragmented and much more complex marketplace with wide ranging new business relationships having to be entered into, at least, until the market settles. This could create specific challenges for supervisory and competition authorities.

4. Competitive Damage and Distortion

Governments have been promoting the development of FinTech in an attempt to increase competition within the financial area specifically. This is necessary to place pressure on existing firms, especially large oligopolistic incumbents, to reduce costs and provide higher quality services to customers. Governments and competition authorities must nevertheless be aware of all of the more sensitive and difficult issues that arise in this area. Incumbents are subject to the costs of maintaining, updating, and replacing multiple legacy computer systems and the higher costs of complying with many substantial post-crisis regulatory reforms. This may, for example,

include having to offer fixed terms or prices to existing customers, rather than adjust their rates accurately to reflect market prices.

The effect of all of this will be to create an unlevel playing field with new FinTech start-up companies for which no specific authority is responsible. While promoting competition is generally fully supported, concerns arise in such areas as financial services, where specific firms, or outliers, reduce prices below cost or generally accepted risk levels, which other incumbents have to compete with. This arose before the financial crisis, for example, with sub-prime lending in the United States and with institutions such as Northern Rock in the United Kingdom being allowed to provide 125 percent loan to value mortgages on very low, and possible self-certificated, income ratios.289 Competition and regulatory authorities must cooperate to ensure that unacceptable market practices do not undermine market stability.

C. INNOVATION AND REGULATORY BALANCE AND CONFLICT

Regulatory and competition obligations must also be properly balanced to promote high degrees of both innovation and market stability. It is arguable that a number of the post-crisis reforms adopted have become excessive and undermine traditional banking and financial function without any appreciable or corresponding improvement in financial stability.290 This may, for example, apply to the introduction of structural regulation (ring fencing) in addition to the existing reforms imposed on banks, especially with regard to capital, liquidity, leverage, governance, remuneration, resolution, standards, and ethics.291 The IMF has recommended that regulatory reaction should be commensurate to the risks involved without limiting innovation.292

An appropriate balance of permission and regulation must be achieved between new FinTech companies and incumbents, as well as with all financial firms more generally, to ensure that market control, regulation, innovation, and advantage are all properly and proportionately balanced.

292. IMF, supra note 52, at para. 66. The IMF developed five regulatory principles governing virtual currencies: regulatory response had to be risk commensurate; responses had to adapt to changes in the new landscape; authorities had to design approaches that would take into account the novel business models inherent within new schemes; regulation had to deal with market conduct issues and the financial soundness of financial intermediaries; and consideration had to be given to the degree of integration between the conventional financial system and the new market. Id.
Specific difficulties could arise in the United Kingdom where the FCA has developed a highly credible Project Innovate facility to support FinTech start-up companies in the financial services area; Project Innovate includes an innovation Hub, advice unit, and Regulatory Sandbox in which the implications of innovative new products, services, and business models can be tested from a regulatory perspective. While the FCA has an express statutory consumer protection objective, care has to be exercised to ensure that market innovation and stability issues are properly balanced, especially with the separate Prudential Regulation Authority (PRA) being responsible for prudential bank supervision.294

D. Users and Stakeholders

A series of related concerns arise with regard to protecting the interests of users and other stakeholders in new FinTech driven systems. Specific issues arise with regard to identification, capacity, control, privacy, and relevant consumer protection, ethical and social standards, as well as government function.

1. Identification and Authentication

Firms need to ensure that customers are who they claim to be and customers need to be able to ensure that their identity has not been misused. This requires error free identification and authentication. Error free identification and authentication can be achieved through the various forms of electronic signatures and digital documentation execution available, and can also be supplemented with the use of cryptographic tools.

2. Legal Capacity and Authority

Firms must also be able to rely on online users having necessary legal capacity and, where appropriate, authorization. This is connected with identification and authentication, although it goes further in ensuring that parties have necessary legal capacity to act and bind themselves or their employers or principals. Where this is relevant to a particular transaction, online service providers may have to undertake additional checks, such as confirming an age or that corporate officers have the necessary authority. This may include providing copies of corporate documentation and board resolutions in larger value cases. The House of Lords ruled that local authorities in London could avoid liability under complex swap contracts on the basis that they had no legal capacity to enter into the contracts and that the hedging transactions were accordingly ultra vires.295

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Capacity is a type of legal risk. Other forms of legal risk include substantive validity, legal execution, judicial recognition, and subsequent execution and enforcement of court judgements. Proper contract drafting involves ensuring that parties have all the necessary rights and remedies, including appropriate self-help remedies, such as netting, set-off, or selling security. Enforcement considerations include ensuring that particular countries have adequate court systems with well-trained and impartial judges that can consider and rule on potentially large value complex commercial facts. Enforcement includes considering insolvency law implications in the event of a bankruptcy of an individual or winding-up of a company, as well as the ability to enforce court orders in particular countries, such as through attachment of funds in bank accounts with execution including the seizure and sale of assets.

3. **Privacy, Confidentiality, and Data Protection**

Customers have to be able to ensure that any information they place on the Internet, or hold in a digital format accessible through the Internet, is subject to appropriate privacy and confidentiality protections. Difficulties may arise where customers are careless in loading information, as well as where firms holding information become susceptible to unauthorized access, attack, or hold information in countries with less protection. Customers must also be able to know that personal information is used in an appropriate manner with necessary data use and exchange protection controls in place. All of these issues become significant concerns where online systems are subject to any degree of possible infiltration and attack. All of this may again become more complex as FinTech expands.

4. **Consumer Protection, Ethics, and Social Responsibility**

Appropriate consumer protection laws and regulations must be imposed in all countries that have an appropriate consumer oversight body in place. Users and other stakeholders must also be able to confirm that FinTech operators or other operators on the Internet behave in an ethical and social manner. This specifically requires that appropriate governance arrangements and ethical codes of practice or conduct be in place. Ethics nevertheless raises difficult issues with regard to the standards to be imposed because they are dependent on popular expectations, which shift over time, but also need to secure an appropriate allocation of loss and responsibility. This is an issue that could be managed by relevant trade associations or other Internet user groups.

5. **Government Function**

All legitimate government interest and functions must be properly protected. This includes ensuring that any operations transferred to

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296. See IMF, supra note 52, at paras. 45-46.
distributed ledgers, such as passport lists or electoral registers, are safe and secure. This would also apply with regard to welfare and pension payments. Care will also have to be taken to ensure that FinTech activities do not facilitate tax avoidance at the national or international level.\textsuperscript{297}

E. GLOBALIZATION

Additional concerns arise with regard to the cross-border nature and impact of many FinTech and other Internet activities in terms of trade and service damage, payment, liquidity and capital stability, competitive conflict, and potential regional or global obstruction.

1. Trade and Service Damage

Disruption to FinTech services may damage associated trade and service activities especially with regard to national and cross-border payment flows. The competitive ascendency of FinTech companies or sectors in specific countries may also damage the competitive position of other trade and service sectors either directly or indirectly.

2. Payment, Liquidity, and Capital Instability

While FinTech platforms may increase payment options, liquidity volumes, and capital mobility, care has to be taken to ensure that all of this is properly managed and monitored. Any damage to payment systems could have substantial knock-on effects in goods and services markets. Appropriate alternative or continuity arrangements have to be in place to support payment patterns in the event of a failure of a specific payment platform. The authorities must also be sensitive to sudden spikes in liquidity provision, consequent debt levels, and a destabilization of capital movement between countries. FinTech operators must also comply with all relevant foreign exchange controls.\textsuperscript{298}

3. Competitive Conflict and Decline

National competitive positions may be damaged by the growth in FinTech activities elsewhere. While competition may benefit local markets, it may damage cross-border sectors and institutions. The development of powerful FinTech centers across the world could damage existing financial centers, such as the City of London, with governments anxious to attempt to protect and develop their position and status.\textsuperscript{299}

\textsuperscript{297} Id. at paras. 47-51.
\textsuperscript{298} Id. at paras. 52-53.
\textsuperscript{299} Adi Levanon, Berlin Bids to Replace London as Post-Brexit Fintech Capital, \textit{FINANCIAL TIMES} (July 6, 2016), http://www.ft.com/cms/s/0/89588b02-e3f9-11e6-8716-a471e8140b0.html#axzz4IrGXhnlS.
4. Regional Delay and Obstruction

Uneven FinTech development within regional systems, such as the European Union, can impact the competitive positions of members of the specific trading block and also those between blocks. Care nevertheless has to be exercised to ensure that regional laws and regulations do not unnecessarily or disproportionately obstruct the development of FinTech activities globally. An appropriate balance has to be achieved in all cases.

5. Global Obstruction and Inconsistency

Equivalent issues arise at the international level with FinTech and non-FinTech sectors possibly being affected by the development of technology activities in other countries. Care must also be taken to ensure that countries are not allowed to adopt inappropriate protectionist positions or that global rules obstruct FinTech evolution more generally. Appropriate monitoring of attendant difficulties and possible instability must also be maintained on a continuing basis.

F. Regulation and Control

A number of separate issues arise with regard to the regulation and control of FinTech activities. Authorities generally have to protect the soundness of individual institutions as well as the integrity of markets. Existing laws governing the regulation and supervision of financial institutions groups will have to be revised to ensure that they cover new simple and extended FinTech structures. This prudential regulation of firms also has to be supported by effective conduct regulation to protect the integrity of specific markets and markets as a whole. This will form part of the newly developing MicroTech regulation and supervision.

A number of specific issues arise with regard to market and institutional regulation, market integrity, relevant laws and protocols, revision, ownership, and market access.

1. Market and Perimeter Regulation

All FinTech activities and other Internet and online operations must be subject to appropriate regulation and governance. Regulatory parameters must be reviewed and reset accordingly. This may include large numbers of different market and official parties being set up with different multi-level governance arrangements. It is desirable that as many operational matters as possible are governed by markets themselves, or by market operators acting in association or collectively, although some level of oversight will generally

300. See generally SWIFT & Accenture, supra note 264 (summarizing the challenges for distributed ledgers in terms of requiring strong governance, data controls, regulatory compliance, standardization, identity framework, security and cyber defense, reliability, and scalability).
be necessary, with possible intervention being used in specific well-defined cases or situations.

Specific difficulties arise with regard to FinTech activities in that these break up or fragment traditional product and service chains. It is necessary to ensure that regulated activities are subject to proper oversight with connecting or ancillary operations also being brought within the scope of regulatory definition and attention. The IMF notes that digital currencies create definitional challenges for regulators with schemes that have been difficult to monitor.

FinTech operators could assist with this by attempting to set up and develop appropriate trade associations and ensure that they act in a responsible manner and reflect the full range of interests involved. The promotion of FinTech and other e-commerce and digital national interests will generally be assigned to a specific government department with particular legal or regulatory issues assigned to specific authorities, such as domestic or regional competition agencies or financial regulatory authorities. All of these bodies must be able to act in a cooperative or coordinated manner to the extent necessary.

2. Market Integrity

Authorities have to ensure that FinTech platforms and activities are not used to facilitate improper conduct, such as insider trading and market abuse. Relevant markets, including digital currency exchanges, must also operate properly and safely without threat of closure or failure and counterparty or customer loss. Concerns also arise with regard to financial system integrity, especially in terms of money laundering and anti-terrorist financing. The European Banking Authority (EBA) issued warnings to customers in December 2013, regarding the threat of digital coin loss, criminal activity, and taxation, with a separate opinion addressed to

301. See Comm. on Payments and Mkt. Infrastructures, supra note 59, at 3, 10-13 (discussing the role of regulation, regulatory issues, and approaches).
302. See IMF, supra note 52, at para. 32.
303. Id.
304. See Ben McLannahan, Bitcoin Exchange Mt Gox Files for Bankruptcy Protection, FINANCIAL TIMES, at 2 (Feb. 28, 2014, 12:35PM), https://www.ft.com/content/66368e58-a06e-11e3-a72c-00144feab7de; see Crypto Currencies, EXCHANGE, THE GLOBAL MAGAZINE OF DE LA RUE, Spring 2015, at 13, available at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0ahUKEwizb8m1tZXPAdUo2IMKHUuQDvQFQggMMAw&url=http%3A%2F%2Fwww.delarue.com%2F%2Fmedia%2FFiles%2F%2F德尔%2FInsight-and-Innovation%2Fdlr-exchange-15.pdf&usg=AFQjCNFRqbcUcDwAIHs0FH3bZipE0Ng. 850,000 bitcoins were stolen from the digital wallet of the Tokyo Mt Gox Bitcoin exchange. Id. Mt Gox was set up in July 2010, but training was suspended in February 2014, and the exchange was placed into liquidation in April 2014. Id.
national competent authorities, the European Commission, Council, and European Parliament in July 2014.306

3. Digital Laws and Protocols

All countries must ensure that they have necessary laws and regulations governing FinTech and other online or Internet related activities. A number of important laws have been developed in key areas, such as recognition of electronic and digital signatures,307 promotion of electronic commerce and digital markets, privacy, confidentiality, and data protection.308 Much of this is, unfortunately, uncoordinated. Appropriate laws should also be prepared where necessary in order to govern other elements, such as to clarify rights and obligations and protect remedy and loss allocation mechanisms. The possibility should also be considered of developing standardized, substantive sets of common terms and conditions or service arrangements to promote uniformity and provide minimum levels of protection for FinTech, online, and Internet usage.

It is also necessary to ensure that appropriate codes or protocols are in place governing the use and operation of technical systems. This is necessary to promote standardization and limit abuse or interference. This should so far as possible be industry and specialist practitioner led although governments may assist in bringing the necessary parties together or possibly in providing appropriate legal recognition or incorporation.

It is specifically necessary to ensure that commonly used technical systems can be properly maintained, such as by removing defects and making necessary reforms or revisions over time. Operational standards will be set out in the relevant protocols, although suitable arrangements must be in place to allow these to be revised or updated as necessary. Specific difficulties, for example, have arisen with regard to the amendment of the core Bitcoin software, with separate schools of opinion emerging. Unavoidable conflicts, delays, or prevention of necessary work must be avoided.

4. Ownership and Participation

Ownership rights to FinTech assets have to be clearly assigned and protected. This may raise difficult issues with regard to the application of traditional intellectual property laws, including copyright, trademark, patent, and other rights in the FinTech and Internet area.309 In addition to

308. See generally id. at ch. 10-11.
309. See generally CHRIS REED, supra note 307, ch. 6-9.
protecting relevant interests, laws must also ensure that intellectual property rights are not abused and that market access is not unnecessarily restricted. This could become a significant problem, as the largest technology firms assume increasingly larger shares of the total global marketplace. Governments should attempt to ensure that appropriate guidance is provided and that domestic laws are revised as necessary in order to provide appropriate protection and competition.

5. Market Access and Development Support

FinTech and mobile communications may specifically be able to assist with exclusion problems in particular countries where, for example, bank account availability levels are low. Low cost and easily accessible FinTech solutions may be able to provide substantial assistance in reducing exclusion numbers. Residual groups may nevertheless still not be able to access a full range or possibly specific financial services or may simply not wish to use them. It is for this reason that alternative cash and non-digital payment methods may have to be continued in almost all societies across the world. This might be considered necessary for constitutional, political, and moral reasons because not all members of all societies wish to convert to using digital savings, payment, investment, and other digital means. This might be referred to as a form of cash retention, market retention policy, “non-net” parallel, or alternative model system.

G. Infrastructure

A series of similar concerns may arise with regard to infrastructure stability where significantly disruptive new FinTech systems are allowed to develop in an unmonitored and unmanaged basis. Specific difficulties may arise with regard to integrity, inter-operability and network connections, integrity, contagion, and wider infrastructure systems stability.

1. Payment System Integrity

Authorities have to ensure that all of the major large value payment systems continue to operate effectively. The CPMI refers to risks to central bank management of the safety and efficiency of payment systems, including explaining value fluctuations, preventing fraud, limiting payment risk, problems anticipating future disruptions, legal risk, settlement risk, and possibly anonymous money laundering and criminal activity. The CPMI also warns about wider infrastructure impact.

The ECB examines the nature of payment-related aspects of virtual currency schemes in further detail, including with regard to key actors and rules, diversity, differences, emerging business models, data, and use of

perspective. Users were nevertheless subject to payment system-like risks including credit, liquidity, operational, and legal risk. Virtual currency schemes were considered not to pose a threat to payment system stability, subject to future changes in connection and increased use and transaction volume.

2. Platform Inter-operability and Network Integration

FinTech devices will need to be sufficiently inter-operable to ensure that they can work with other common or standard program systems, as non-operable models will be ineffective and uncompetitive over time. Inter-operability of itself may cause concerns where a rogue system or unauthorized access through a new system could damage connected programs or platforms.

The inherent need to connect systems to larger networks exposes the networks to component attacks either directly, through defects in the component’s software parts, or indirectly, through unauthorized access through the inclusion of insertion of new components within a larger network or chain. Individual components create complexity risks in themselves, while the establishment of new systems connections necessarily increases overall network risk.

3. Attack

FinTech and other electronic and digital systems are never immune from intervention or attack. Full systems or networks and any component within the network then become vulnerable to attack through any point of access within the extended system created, and as such, the risk of attack is accordingly magnified manifestly due to the susceptibility of any point in extended network chains and component parts.

4. Confusion and Contagion

The high degree of inter-operability, connection, and speed of transmission substantially increases the further risk of contagion. The nature of the uncertainty created becomes substantially greater through emergent effects within the complex and dynamic chains of causation that arise as a result of the combination of network complexity and complexity within individual component parts within the system.

312. ECB, supra note 53, at 7-22.
313. Id. at 42.
314. Id. at 37.
5. Systems Infection and Insulation

Infrastructure systemic risk is substantially magnified for all of the aforementioned reasons. It may be necessary to consider how various forms of insulation and separation, such as with circuit breakers, could be established to limit contagion between network parts. It would also be necessary to ensure that appropriate continuity planning arrangements are in place, including necessary means of transferring technology or core accounts to new systems service providers as necessary.316

H. Central Banking and Monetary Policy

Domestic authorities will have to ensure that significantly disruptive FinTech activities do not create unnecessary or unavoidable difficulties in managing domestic or regional monetary policy and stable international financial monetary arrangements more generally. Domestic monetary policy is generally based on certain specific objectives, including, most commonly, price stability, and some form of targeting, such as inflation or foreign exchange rate measures. FinTech functions may raise specific difficulties in this area, especially where private digital currency systems are allowed to expand substantially, which could destabilize domestic currencies either in the same or another country. Specific concerns then arise with regard to the conduct of domestic monetary policy, managing liquidity and credit supply and protecting price stability, as well as regional and global market stability more generally.

The ECB examined the relevance of virtual currency schemes for central banks in terms of risks to price stability, financial stability, payment system stability, regulatory loss, and reputational risk.317 The implications of digital currencies for central banks were considered by the CPMI in terms of payment systems, financial stability, and monetary policy, including market infrastructure, financial and market intermediation, bank seigniorage and monetary policy, as well as the possible issuance of digital currencies by central banks in the future.318 Distributed ledger technology was an important innovation that could have substantially wider applications, especially with regard to financial market infrastructures (FMIs) and the wider economy. Central banks had to continue to monitor and assess the implications of the development of digital currencies and distributed ledger technology over time.319 Few specific conclusions were drawn at this stage, and further work is required.

316. See id.
319. Id. at 14-16.
1. Monetary Control and Oversight

Domestic monetary authorities must ensure that they are able to comprehend all monetary conditions in a particular country. This will involve having all necessary data and information available, including with regard to new FinTech tools, and especially with regard to payment and lending. Authorities must be able to monitor the development of FinTech activities to ensure that these complement and support, rather than undermine, stable domestic monetary conditions. The CPMI notes that monetary policy effects were expected to be similar to potential e-money impacts, which were examined by the BIS in 1996.

2. Liquidity and Money Supply

Authorities must continue to be able to ensure an appropriate money supply on a continuing basis. This is generally secured by maintaining sufficient notes and coin in circulation with an appropriate level of lending and credit supply, and with commercial banks also being able to draw under wholesale central bank facilities as necessary. In practice, this is often dealt with through the use of central bank base or bank rates and open market operations. This could be substantially undermined if a sufficiently large volume of a private digital currency was allowed to amass without official control or management.

The IMF concludes that virtual currencies did not present any significant implications for monetary policy at the present time, although this could change with increased use. The Bank of England also notes that the monetary policy implications of digital currencies were minimal to the extent that digital currencies were only used for limited payment volumes, with some possible fragmentation arising where a group of individuals sought only to transact in digital currency. The most significant issues would arise where the economy became “Bitcoinised” over time and with a substantial abandonment of sterling for payment purposes, although this was considered an unlikely event given the current impediments to the

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320. IMF, supra note 52, at 33-35; see also Comm. on Payments and Mkt. Infrastructures, supra note 59, at 16.
323. The IMF adds that the fixed supply nature of currencies could result in structural deflation with the loss of a flexible money supply, the ability of monetary policy to manage the business cycle could be diminished over time, virtual currencies could not easily replace the lender of last resort function of central banks with institutions having to be able to provide emergency liquidity to avoid crises and that it was expected that virtual currencies would be more widely adopted in countries with less credible monetary policy systems. IMF, supra note 52, at 33-35.
widespread adoption of digital currency schemes and the implausibility of a severe collapse in confidence in fiat currency.\textsuperscript{325}

Many central banks may still consider issuing “blocks” of digital currency, either directly or indirectly, through private banks or other currency suppliers.\textsuperscript{326} It has to be expected that this will be tightly controlled at the beginning, with digital currency blocks simply replacing equivalent amounts of notes or central bank reserve balances. Such digital money will generally be denominated in the form of the country’s official currency and reference asset, thus allowing commercial banks to issue blocks of currency under central bank permission and oversight which would have the advantage of transferring system management costs to private banks. An appropriate model for this would be the production of private bank notes by Scottish and Northern Irish notes in the UK, with issuing banks effectively purchasing the right to issue their own notes by depositing an equivalent amount of sterling notes with the Bank of England.\textsuperscript{327}

3. Credit Supply

Closely associated with ensuring that sufficient continuing liquidity is made available within the system is managing credit supply. Most economies ensure the provision of credit on a flexible basis by delegating private lending to commercial banks that assess and price credit quality on an individual basis. Funding for this purpose is made available partly through the banks’ deposit base and secondary market activity, including inter-bank borrowing, but where necessary, the larger banks can always draw further funds down from the central bank through their reserve balance accounts at the prevalent bank or discount rate. While the system is often criticized for being private bank-based, the model is highly flexible and has worked well for around 300 years while specifically avoiding the politicization of the credit process.

Equivalent difficulties would arise in ensuring an adequate and flexible supply of credit as ensuring necessary liquidity for general payment or emergency lender of last resort purposes. It is not possible to see how this could work as stably or effectively using a private digital currency, such as Bitcoin in particular, with a fixed volume of supply and fluctuating value. It

\textsuperscript{325} Id.
\textsuperscript{326} The Bank of England has examined the macroeconomic effects of issuing Central Bank Digital Currency (CBDC) with a CBDC issuance of 30 percent of GDP against government bonds raising GDP by 3 percent due to reductions in real interest rates, distortionary taxes and monetary transaction costs. Countercyclical CBDC price or quantity rules could also improve the central bank’s ability to stabilise the business cycle as a secondary monetary policy tool. \textit{See} Barrdear & Kumhof, supra note 66, at 3; \textit{see also} Comm. on Payments and Mkt. Infrastructures, \textit{supra} note 59, at 16-17.
is accordingly unlikely, again, that authorities would allow private digital currencies to replace existing central bank-controlled monetary arrangements supported by private bank credit provisions outright.

4. *Price Stability*

Connected with the issues that would arise in terms of liquidity and credit supply would be the need to protect the value of the dominant domestic currency in place over time, as well as wider price stability.\(^{328}\) It is necessary to manage the value and control inflation growth over time. Most central banks do not attempt to ensure a zero inflation rate, but a low rate of between two and three percent to reflect a general increase in the money supply and economic demand over time. It could be impossible for central banks to manage price stability and inflation if countries generally converted to a private digital currency model.

5. *Regional and Global Monetary Stability*

Substantial domestic currency disruption could easily be transferred to a regional or global level quickly, where unofficial private digital currencies are allowed to expand quickly in one or more countries and where these are not tied to an official domestic reference currency asset. Different experiments with official and private digital currency models could have significant regional and global impacts, with countries being materially damaged by instability imported from another country through the absence of local country oversight. Difficult issues of regional and global cooperation and coordination could clearly arise in this area. The emergence and growth of private money models could make the need for regional and international monetary coordination of more importance, with the IMF and the BIS assuming an important role in this regard.

I. *Financial Stability*

While FinTech may bring substantial benefits, significant potential financial stability difficulties also arise with the heightened risks involved, in addition to the issues concerning technology, business disruption, user and stakeholder interest damage, globalization, regulation, infrastructure, and monetary policy. While the issues that arise with regard to digital currencies have been considered by a number of official bodies, including the IMF, BIS, ECB and the Bank of England and other national central banks, FinTech has received less direct attention.\(^{329}\)

Mark Carney, as chairman of the FSB, announced in February 2016 that FinTech developments would be brought within the areas of consideration

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329. The IMF paper on virtual currencies warns about potential financial stability issues if market values and transaction volumes increase. IMF, *supra* note 52, at 31-33.
of the FSB, with specific work being carried out during 2016 and the FSB reporting end of summer.\textsuperscript{330}

Some of the specific important issues that arise may be considered in terms of regulation, revision, resolution, and oversight. These key areas of the defect in overall market control that contributed to the global financial crisis remain of continuing relevance to date.

1. \textit{RegTech and FinReg}

New FinTech activities must be subjected to an appropriate regulatory framework and necessary standards. While RegTech will be of assistance in improving firms’ ability to comply with existing general, and possible new FinTech obligations, this only represents the area in which technology assists compliance. Difficult issues also arise with regard to the wider FinTech environment with this larger regulatory framework being referred to as FinReg for the purposes of this text. Existing regulations, or new regulatory requirements, may have to be extended and adjusted as necessary.

Regulatory parameters must be reviewed to ensure that all FinTech-related activities are properly controlled. New regulatory obligations may specifically include additional governance requirements on FinTech product services or relations, FinTech product and company acquisitions, outsourcing and with appropriate adjustments being made to capital, liquidity, and leverage ratios as necessary. Other, more particular regulatory, obligations may have to be considered over time.

Appropriate obligations must also be imposed on both new FinTech market entrants and incumbent firms as necessary. Relevant minimum standards must be imposed in all cases. The issue of the uneven playing field that has been created has already been referred to, with incumbent firms

\textsuperscript{330} Mark Carney stated in a letter to G20 Finance Ministers that, “A number of technological innovations with potentially transformative implications for the financial system, its intermediaries and users are now receiving close attention.” He added that, “The regulatory framework must ensure that it is able to manage any systemic risks that may arise from technological change without stifling innovation,” and that “The FSB is evaluating the potential financial stability implications of emerging financial technology innovation for the financial system as a whole, working with standard setters that are monitoring developments in their respective sectors.” He noted that “We are also working to understand better the potential impacts on financial stability of operational disruption to core financial institutions or infrastructure.” Fin. Stability Bd., \textit{To G20 Finance Ministers and Central Bank Governors} (Feb. 22, 2016), at 6, http://www.fsb.org/wp-content/uploads/FSB-Chair-letter-to-G20-Ministers-and-Governors-July-2016.pdf. The FSB noted following its meeting in Tokyo on 30-31 March that, “The Plenary reviewed major areas of financial technology innovation, including distributed ledger technology, and proposed a framework for categorising them and assessing any financial stability implications. Plenary members discussed the issues raised for public authorities by these technologies, possible steps to address potential risks, and opportunities for cooperation in the FSB and with the standard-setting bodies to deepen analysis and develop regulatory perspectives.” Fin. Stability Bd., \textit{Meeting of the Financial Stability Board in Tokyo on 30-31 March,} at 3, Ref No: 6/2016 (Mar. 31, 2016), http://www.fsb.org/wp-content/uploads/Tokyo-plenary-press-release.pdf.
being under a substantial cost disadvantage that regulatory and competition authorities should take into consideration in the longer term.

2. **FinTech Supervision (SuperTech)**

The term RegTech includes a number of devices that are essentially more supervisory and reporting-related than regulatory in nature. RegTech may substantially assist wider FinTech supervision. Authorities must also be able to supervise all relevant risks at the firm level, with firms having all necessary reporting obligations in place and authorities having appropriate systems to receive, examine, and analyse the data provided and take relevant action as necessary. Ensuring effective FinTech oversight at the firm level may be referred to as “MicroTech” as opposed to wider “MacroTech” systems oversight, which would form part of an extended form of macro-prudential monitoring.

3. **FinTech Resolution (ResTech)**

Existing post-crisis resolution mechanisms should also be extended to deal with any potential new FinTech exposures. This should again apply both with regard to new market entrants and incumbents. The objective would specifically need to ensure that the failure of a specific platform, program, or firm did not materially disadvantage customers or other financial counterparties, or generate wider systemic threats or exposures. Larger FinTech companies that become subject to authorization and supervision should be required to comply with relevant resolution requirements, including preparing Resolution and Recovery Programs (RRPs). This could either be on a bank and security firm or possibly a major infrastructure firm model. This would certainly apply where any FinTech company grew to such an extent that it was considered to be systemically relevant or important. A new category of systemically important FinTech companies (‘SIFTCs’) or systemically important FinTech risks (SIFTRs) categories could be created.

Of more importance in practice would be ensuring that all client accounts or other client, firm or market data could be moved quickly and efficiently in the event of the failure of a specific FinTech platform or program. This could either take the form of technology, or an account transfer mechanism. This is related to the inter-operability point referred to earlier, with systems being designed in such a way that they allowed for quick restoration or transfer.

Relevant official resolution systems, including the Special Resolution Regime (SSR) arrangements set up under the Banking Act 2009 in the United Kingdom, would also have to be reviewed and revised as necessary to

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allow for official action to be taken in the event of a FinTech company failing to avoid possible user, counterparty, or other stakeholder loss.

4. Lender of Last Resort (LLR) and Technology of Last Resort (TLR)

Where official bodies were involved, this might be considered to involve a form of Technology Restoration Program (“TRP”) or Technology Transfer Program (“TTP”) with official bodies, such as regulatory authorities or central banks, possibly ultimately having to act as Technology providers of Last Resort (“TLR” or “TpLR”), at least for a period, to protect critical systems and accounts in a crisis management situation.

5. MacroTech

All of the new FinTech systems, relations, and possible impacts on other financial systems and the wider economy will also have to be monitored over time. The regulation and supervision of FinTech companies will, to the extent necessary, be dealt with on a MicroTech basis, which would include both the regulatory and supervisory aspects of controlling FinTech activities at the firm level. This would then be supplemented by a wider macro-prudential, or MacroTech, function at the systems level. The most appropriate agencies to undertake this task would be the FSOC in the US, EBRD in the EU and FPC in the UK, as well as the FSB at the international level more generally.

X. Financial Technology Comment and Conclusions

The new FinTech world will create significant challenges and opportunities. This may bring substantial longer-term customer, firm, government, and wider economic and social advantage. It is only necessary to manage all of the new risks and exposures created and limit any more significant damage beyond the underlying and necessary technological disruption that will drive marketing and business innovation in these areas.

The following, more specific, provisional conclusions may be drawn with regard to the FinTech revolution at this time.

A. FinTech

The meaning of FinTech remains subject to debate. Pro-FinTech and anti-existing market commentators generally adopt a narrow approach based on new entrant control technology and significant incumbent market disruption. FinTech companies are clearly forcing change in the structure and operation of many aspects of banking and financial service provision and market operation. A number of the largest incumbents are nevertheless responding to the FinTech challenge positively by developing their own internal technology laboratories and innovation platforms, as well as investing in and supporting new FinTech firms and practices.
Many FinTech companies also have to operate with existing institutions to benefit from their size, customer base, capital, existing financial regulatory expertise and licenses, and supporting personnel and compliance systems. Many veneer operations may only focus on the development of new customer interfaces and services at this stage in their evolution cycle. Some companies, such as TransferWise, have been able to grow and separate themselves from their supporting regulated institution, although many others may either continue to work with or be absorbed into existing financial institutions or groups. FinTech is expected to have a significant impact on banking and financial markets, although much of this may be more internal, voluntary and passive rather than external, forced and destructive.

For the purposes of this text, a more general and inclusive meaning of FinTech is adopted based on the use of technology to improve the provision or carrying out of financial function and, in particular, savings, lending, payment, investment, and risk or loss management. This will include internal and external developments as well as full and partial systems changes. This may also be public or private sector body-driven and include developments at the national, regional, including European, and international levels. FinTech itself is also viewed in positive and constructive, rather than negative and destructive, terms.

B. DIGITAL CURRENCIES, COINS AND CLAIMS

FinTech developments will have an impact across the banking and financial area. This was initially expected to focus on customer interfaces, principally through new mobile telephone applications, and then payment, including foreign exchange services. This has extended into credit provisions, especially through microfinance and then peer-to-peer lending and crowdfunding, as well as through the provisions of the development of automated (Robo) credit assessment, trading and advisory software programs in the banking, securities and insurance areas. The development of new electronics and digital-based technology has already had a significant impact in the securities area, including with algorithmic trading, high frequency trading (HFT), and the construction of a large number of electronic stock markets and exchanges (including ATPs, ATSs, ECNs, MTFs, OTFs, and systemic internalizers).332

More significant impact may potentially occur in the area of the development of digital currencies and other assets, including digital securities and digitally-based insurance, including through smart contract provisions. The most important new digital coin has been Bitcoin, which has confirmed the potential value of distributed ledger technology. Bitcoin nevertheless suffers from a number of significant disadvantages, including with regard to speed, block size, mining dependence, waste, amendability, governance, limited supply, and total quantitative limits, as well as a

332. Financial Markets and Exchanges Law, supra note 104, at 77-78.
substantially fluctuating value. It is highly unlikely that a private distributed model currency such as Bitcoin could replace existing official currency systems, at least in the near future.

Central banks could still use distributed ledgers to produce official digital coins in “currency blocks,” or “block coin,” which would replace specified amounts of existing note production, with physical coin and note circulation operating in parallel with official digital monies. Central banks in particular countries may also decide to allow some private production of digital coins, although this may, at least, be made conditional on depositing an equivalent amount of domestic currency to support the private issue.333 Regulatory authorities may also allow other private token systems, not denominated in the form of an official reference asset, to be used to the extent that these do not threaten the stability of domestic currencies or monetary arrangements, or operate within available exemptions. A range of regulatory provisions may nevertheless still be applied, including with regard to payment regulation, anti-money laundering and terrorist financing controls, data protection, and other consumer protection measures.

It has to be expected that a number of new FinTech operators will continue to develop alternative digital asset value systems which can carry out many of the same functions as traditional official domestic currencies.334 These may be attractive to particular groups of users or members of society in particular countries, as with Bitcoin. Many systems users may nevertheless wish to continue to use official currency or new official digital currency assets, at least for high-value or long-term savings purposes in light of the security and value protection provided. A mixed digital market model may accordingly emerge, although this would continue to be underpinned by official currency assets and monetary management.

C. DIGITAL CLASSIFICATION

Significant difficulties remain with regard to the proper legal classification of digital currencies, especially in terms of property law.335 Various opinions have been expressed, although these are generally inconclusive, and the matter remains unresolved pending judicial determination or statutory clarification.336 Conflicting positions have been adopted in the U.K. and in

333. A model for this already exists with the deposit of Bank of England notes by Scottish and Northern Irish banks under the revised currency arrangements contained in Part 6 of the Banking Act 2009. See Banking Act 2009, c. 6 (Eng.); The Scottish and Northern Ireland Banknote Rules 2015 (Eng.), supra note 327.
334. See Crypto-Currency Market Capitalizations, supra note 120.
335. Bridge specifically notes that defining property is “surprisingly difficult... at a general level.” MICHAEL BRIDGE, PERSONAL PROPERTY LAW 12 (Oxford University Press 4th ed. 2015).
the U.S. on the point. Under English law, property is generally divided between land and personal property. Personal property is considered in terms of tangible and intangible, which either consist of choses in possession or choses in action. Intangible moveable property generally is comprised of documentary intangibles which are instruments representing goods, such as bills of lading, or financial instruments, including bills of exchange, promissory notes and cheques, and pure choses in action which are personal claims. A number of distinct types of choses in action can be identified which can be considered to include rights under contracts.

Property is given a wide and inclusive statutory definition for insolvency law purposes under English law. The courts will apply a four-point test based on definition, identification, transferability, and permanence. The importance of independence has also been highlighted and common rights stressed. For the purposes of this text, these rights may be summarized in terms of holding, encumbering by way of security, bequest (and inheritance),
transfer (including by gift or sale), and cancellation or destruction. Other writers also develop the idea of independence or separation. The nature of rights has been subject to separate theoretical examination.

While digital currencies would satisfy the various conditions referred to, including definability, identification, transfer, permanence, as well as independence, or separability, and protectability, the core difficulty remains in identifying the precise nature of the property interest concerned. Digital currencies, such as Bitcoin, do not create rights of actions against other individuals, or entities, as with banknotes or bank accounts. Digital currency is not issued by a specific issuer. Holders of digital currency arguably do not have any separate property interest in the distributed ledger or block chain as a whole.

Despite these difficulties, it is arguable that the owner of a digital currency owns, or more specifically holds, the rights attached to the currency including specifically to sell (or gift) it with the ancillary title rights referred to of encumbering, bequeathing and cancelling. The property interest is arguably then in the rights attached to the digital asset. Bitcoin specifically is only defined as a ‘chain of digital signatures’ to which a series of associated rights can be considered to be attached.

Other types of intangible property can be considered in terms of collections of rights. EU allowances (EUAs), created under the EU Emissions Trading Scheme (ETS) have been defined as the ‘sum total of secure debts, acquired (in the olden days) by a husband on marrying its owner.” OBG Ltd. et al. v. Allan et al. [2008] 1 AC 66, per Lady Hale.

345. These are referred to as the core title rights for the purposes of this paper.
347. Hohfeld classifies legal interests as rights, privileges, powers and immunities with corresponding, or opposite, inabilities (no right), duties, disabilities and liabilities. Wesley Newcomb Hohfeld, Some Fundamental Legal Conceptions As Applied in Judicial Reasoning, 23 YALE L.J. 16, 58 (1913); Hohfeld, Fundamental Legal Conceptions As Applied in Judicial Reasoning, 26 YALE L.J. 710, 717 (1917).
349. Id.
350. Id.
351. It is arguable that the holder of a digital currency cannot destroy the currency as such, which is dependent on controlling the ledger or block chain, although a party may unilaterally declare an amount of digital coin cancelled and refuse to transfer it further which would block any subsequent use. See Blockchain, INVESTOPEDIA, http://www.investopedia.com/terms/b/blockchain.asp (last accessed Sept. 13, 2016).
rights and entitlements conferred on the holder pursuant to the ETS.354 Corporate securities and, in particular, dematerialized securities issued without a physical certificate, can also be considered to constitute bundles of associated rights.355 Interests in securities are also intangible rights with real rather than personal actions being available to protect them.356 A digital right does not have to be enforceable against a specific individual with this having been rejected by the English courts.357 The fact that a new digital asset is created by way of a private scheme controlled by computer protocols and code rather than a statutory or public scheme may also appear to be irrelevant to whether a new property asset has or has not created.358

Although the matter remains untested, a digital right can arguably be considered to constitute property in the form of a special chose in action with a series of associated title rights to hold, encumber, bequest, transfer (by gift or sale) or cancel. The digital asset is definable, identifiable, transferable, stable and independent. The digital coin does not have to be enforceable against a specific issuer although the rights attached to the asset may be enforceable against society generally while a personal action will lie against the transferor for any defect in the transferred title. This may also apply with regard to any scheme established privately or by public statute. The law could nevertheless still be clarified either by classifying digital assets as special choses in possession (through legislation or the development of a judicial doctrine of constructive digital possession) or, at minimum, by attaching expressly real effects for transfer, security and title registration purposes and real remedies in the event of interference to ensure the full and proper protection of such increasingly important assets under law.

D. TECHRISK AND FINRISK

All FinTech related exposures have to be properly identified and managed. This may be considered in terms of technology risk (TechRisk) and larger

354. Armstrong DLW GMBH v. Winnington Networks Ltd. [2013] EWHC (Ch) at para. 50 (Eng.).
355. These rights would include to information, voting at general or special shareholder meetings and a right to payment by way of dividend. Pretto-Sakmann, for example, concludes that shares are not personal property due to the significant contractual element. ARIANNA PRETTO-SAKMANN, BOUNDARIES OF PERSONAL PROPERTY LAW: SHARES AND SUB-SHARES i (Hart Pub. 2005).
356. Benjamin notes that interests in securities are intangible rights. While intangible rights and obligations both constitute property in the form of things, real rather than personal actions are still available against third parties. JOANNA BENJAMIN, INTERESTS IN SECURITIES 307 (Oxford Univ. Press 2000).
357. See Armstrong DLW GMBH, [2013] EWHC (Ch) at paras. 48, 61 (Eng.) (enforcing a digital right is unnecessary).
358. See Re: Celtic Extraction Ltd [2001] Ch 475 (CA) (confirming the need for a statutory scheme of establishment in the English license cases). But see Swift v Dairywise Farms Ltd [2000] 1 WLR 1177, 1217F [2001] (indicating that it may be sufficient even if the quota system had been set up by some private rather than statutory arrangement provided it has commercial value and legal effect). For similar comment, McGrath, supra note 336, at 27.
FinTech systems risk (FinRisk). Technological advance does not necessarily create new forms of risks as such although it does create new applications of existing risks which may be amplified and have additional contagious effects. The principal new sets of exposures that have to be considered with regard to FinTech are operational and technology related risks which may arise inter alia in the form of design error, program flaw, manufacturing defect, non-interoperability and connection failure as well as other types of operational risk including internal and external fraud and systems failure. This may also create increased cost and complexity and require specialist installation, maintenance, management and correction as well as emergency intervention. The overall effect of this may be to create increasingly high levels of technological dependence the effects of which could be more severe in the event of technology failure if there was no technological or non-digital monetary substitutes available. Significant concerns accordingly arise both with regard to dependence and substitution or replacement.

A series of additional issues may also arise with regard to how this technology would work with other technology and in a larger economy. This would create further issues with regard to single systems complexity, connection or network risk, complex causation or emergence, possibly massively increased uncertainty and increased overall aggregate or total risk. All of these new exposures and threats will have to be identified, measured and managed effectively over time.

E. LAWTech and TechLaw

Additional legal risks also arise in connection with FinTech. FinTech companies have to ensure that they and their products or services comply with all relevant laws including applicable restrictions on financial promotions, licensing, authorization and permission, raising funds, consumer credit provision, general consumer protection laws trading on stock markets and exchanges and complying with other relevant banking, securities and insurance laws.

This has to be considered from the perspective of both the law applicable to FinTech solutions (LawTech) and all of the other additional areas that would apply in using technology in the financial area more generally (TechLaw).

Specific private and public law issues arise with regard to FinTech directly. These include advertising and financial promotions, contract negotiation (possibly using standard terms and conditions and service arrangements), contract execution (including electronic and digital signatures), privacy and confidentiality and contract and data protection. The complexity of consumer protection may require the addition of a new form of FinTech related consumer protection law (or ConsumerTech). Other public law issues would arise with regard to criminal offences, including theft and fraud, slander and libel, harassment, stalking and hacking. Many aspects of traditional private and public law will have to be reconsidered to confirm their relevance and use and application in the FinTech area.
F. REGTech and FinReg

Developments in compliance technology and RegTech will substantially assist firms monitor and manage the financial risks that their activities generate and report these more efficiently and effectively to supervisory authorities. RegTech could substantially increase the quality of internal firm risk management and external supervisory oversight and consequent financial stability overall. A number of initial initiatives have been adopted in such areas as data analysis and almost real time reporting.

RegTech is nevertheless only concerned with the use of technology for compliance purposes with a wider area of FinReg emerging which is concerned with the need to regulate the FinTech sector as a whole and banking and financial institutions and markets affected by FinTech developments more specifically. This can be considered to constitute a particular form of technology connected financial regulation more generally although FinReg would extend to overseeing the financial system as a whole and dealing with all potential new risks and exposures.

G. Financial Resolution and TechResolution (or ResTech)

As well as technology related regulation and supervision, a key issue would be ensuring that FinTech companies and products are subject to adequate resolution mechanisms. Resolution became a key issue following the global financial crisis as a number of firms had grown to such a size and complexity that the authorities considered that it was impossible to close them down with official financial support having to be provided.359 One aspect of dealing with this too-big-to-fail problem has been the need to construct effective crisis management mechanisms to ensure that all large banking, securities and insurance firms are subject to effective resolution. This includes both pre-crisis firm internal Resolution and Recovery Programs (RRPs) with subsequent external official Special Resolution Regimes (SRRs)360 being available in the event that the RRPs fail. Many of the largest financial groups have had to prepare their own RRPs with authorities ensuring that they have the necessary powers under their SRRs procedures to deal with any major crisis.

These arrangements will have to be extended in the FinTech arena especially where service providers, platforms or devices become systemic (SIFTCs) or even materially disruptive. The most effective way of dealing with this may be through the establishment of new specialist Technology

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360. See Banking Act 2009, supra note 327 (establishing a dedicated Special Resolution Regime (SRR) for banks following the global financial crisis under the Banking Act 2009 which includes private bank transfers, bridge bank and nationalization options as well as a special bank administration procedure and bank insolvency procedure); see also Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank), Pub. L. No. 111-203, 124 Stat. 1376 (2010) (providing an Orderly Liquidation in the US under Title II).

Difficulties have arisen in this area in developing an appropriate set of rules to govern Internet contracts despite repeated attempts. The most appropriate solution will probably be some form of direction or targeting theory which operates on the basis of the law from where a service is provided as well as the law of the country into which services are directed or targeted.365 This could either operate on a simple or adjusted basis with the two separate laws applying to different aspects of the contract or relations.366 In the absence of international agreement and any clear set of governing provisions, online counterparties could attempt to apply targeting theory principles in common standardized digital contracts which would effectively reflect party implied intention. New principles of international Digital Private Law (DPL) may then emerge.

Parties may also wish to consider using some form of alternative dispute resolution (ADR) in the digital area which may evolve into a form of “Digital Dispute Resolution” (DDR) or Online Dispute Resolution (ODR).367 ADR generally operates either through formal arbitration or informal mediation or conciliation all of which could be adjusted to apply in the digital area.368 This could save substantial costs and make settlement quicker and easier. Specialist “digital arbitrators” could be appointed using agreed panels of existing arbitrators or specially trained arbitrators appointed by technology relevant private trade associations or technology connected public bodies. Special sets of digital arbitration, mediation and conciliation rules could then be developed for specific use in online transactions. The objective would not be to avoid or replace domestic law but clarify its relevance and application. Supporting “digital execution” measures could also be

365. See Regulation (EC) No. 593/2008, supra note 364, at art. 6(1)(b); Council Regulation No. 44/2001, art. 15(1)(c), 2000 O.J. (L 12) 1 (EC); Regulation (EU) No. 1215/2012, art. 17(1)(c), 18(1), 2012 O.J. (L 351) 1 (protecting freedom of choice with consumer contracts governed by the law of the country of the contract supplier or habitual residence of the consumer where the supplier “by any means, directs such activities to that country”).
366. See Michael A. Geist, Is There A There? Toward Greater Certainty for Internet Jurisdiction, 16 BERKELEY TECH. L.J. 1345 (2001); Thomas Schultz, Carving up the Internet: Jurisdiction, Legal Orders, and the Private/Public International Law Interface, 19 EJIL 799, 819-22, 838-39 (2008) (supporting the adoption of some form of targeting approach as opposed to either an activity or effects test supported by possibly home and host state technological filtering of offensive material by internet service providers (ISPs)) (while this would apply vertically, Internet communities and groups could also develop separate horizontal standards to promote practices).
367. See Regulation (EU) No 524/2013, 2013 O.J. (L 165) 1 (adopting online dispute resolution (ODR) platform); Commission Implementing Regulation (EU) 2015/1051, 2015 O.J. (L 171) 1; see also, Civil Justice Council, Online Dispute Resolution for Low Value Civil Claims (Feb. 2015) (reporting on the establishment of an Internet based service for the resolution of civil disputes of less than £25,000) ODR is used in this text to refer to wider global initiatives which will include European and other domestic exercises.
developed to allow for the practical enforcement of digital awards domestically and across open border basis.

I. DIGITAL IDENTIFICATION, EXTENSIONS AND THE DIGITAL ECONOMY AND GOVERNMENT

A number of digital techniques could clearly be extended from the prevailing sale and social media area to operate in connection with FinTech activities. These could then be further extended into other private and public law areas. Work is already being carried out in connection with the development of legal entity identifiers (LEIs) for banks which could be extended to cover all other firms and parties. An equivalent set of digital standard identification systems could also be brought into effect for transactions which would include the nature of the transaction, date of execution (or completion or both) and the identities of the parties involved. All of this could substantially assist ensure the accuracy and effectiveness of identification procedures used online and, in particular, ensure that all parties had relevant legal capacity to act and authority as well as limit money laundering, other criminal activity and tax evasion.

Specific digital tools, such as the distributed ledger, could also be extended for use in other areas which is already being considered. This could include land registers, vehicle ownership registers, other high value asset registers, such as art, and other official government, public and private record systems. The advantages would be reduced public cost and speed of transaction with continuity planning being enhanced with the existence of multiple parallel registers. The disadvantages would be the openness of the system to multiple attacks depending upon the extent to which interference could be limited in multiple access permissioned or permissionless systems. It is highly likely that appropriate models will be developed in time that allow for a sufficient degree of security with separate systems or hybrids possibly being used for closed and open public and private registers in parallel.

Digital technologies developed in the FinTech area could then be extended to apply in many areas of government and society more widely. This would assist create a more substantial Digital Economy as proposed by many governments and predicted by many commentators. This would be

369. A Legal Entity Identifier (LEI) Regulatory Oversight Committee (ROC) was set up in January 2013 to coordinate the development of a Global LEI System based on unique 20 character, alpha-numeric LEI codes for every entity engaged in financial transactions. A separate Global LEI Foundation (GLEIF) was established on June 26, 2014 in Zürich following recommendation by the FSB. The Legal Entity Identifier Regulatory Oversight Committee – LEI ROC, LEI ROC, https://www.leiroc.org (last visited Sept. 2, 2016).
370. Jeroen van Oerle, Patrick Lemmens, Distributed ledger technology for the financial industry 7 (Robeco 2016).
371. Id.
further enhanced by the identification systems referred to earlier. Care would simply have to be taken to avoid unnecessary attack, interference and abuse. Parties should be prepared to provide accurate and valid identification, and authority to act where necessary, in a wide range of transaction arrangements including for official purposes and other high asset value related transactions. Parties should not be allowed to use the anonymity of the Internet to avoid proper identity disclosure and liability in appropriate cases. While this may facilitate increased monitoring in these areas, this should not objectionable in theory where identification is relevant for legal purposes.

Separate issues arise in connection with other non-official and smaller value exchange transactions as well as on social and media platforms. While controlled, transparent and anonymous registers, including distributed ledgers, may be necessary in official and high-value transactions; open, permissionless ledgers may be used in other cases including smaller value purchase and sale transactions using either official or private digital currency. Parallel closed and open systems may then operate. Certain issues arise with regard to identity disclosure on social media sites where people commonly use pseudonyms. This is not objectionable provided that everyone is aware that alternative names are commonly used and that identification is not guaranteed provided that no separate illegal or criminal activity is involved. People have to be responsible for their own conduct and for the treatment of others on social media platforms with appropriate controls and remedies put in place as necessary.

J. Private Systems and the NonNet

Separate issues again arise as to whether it may ultimately be possible to replace all existing physical coin and note production through public or private digital currencies. Specific concerns already arise with regard to financial exclusion and non-bank communities in many parts of the world. While digital facilities have extended bank account and other financial services availability substantially across the world, this may always be far from complete for unavoidable practical reasons or simply through user or consumer choice in particular cases.373 There may accordingly always be an argument to retain some form of cash or physical exchange markets especially for small value transactions. Internet facilities may specifically not be available in all countries, or parts of countries at all times, with the need for a “NonNet” as well as the new Internet and digital commercial marketplace and society.374 A number of legal arguments may be developed to support this either on constitutional, human rights, political, moral and ethical grounds. Governments and legislatures must be aware of the issues involved.

374. Id.
K. Digital Documentation and International FinTech

The commonality of the Internet and worldwide web create new levels of interconnection never before experienced in domestic and international commerce and in human history. Markets have become also more open through specific public international law initiatives, such as with the GATT, WTO and separate trade rounds, as well as globalization more recently. The degree of connection created has been substantially further enhanced by the integration facilitated by the Internet. As digitally connected companies deal with counterparties and customers across the world on common terms, standard sets of terms and conditions and practices will inevitably emerge. This could then support the development of common standardized provisions in many areas of activity, as already occurs with the provision of online services and consent clauses, provided only that these were fair and balanced and accepted across countries and jurisdictions. A degree of digital standardization could then be promoted either by financial or technology related trade associations or by relevant government agencies. Standard sets of common digital terms and conditions could then be produced quickly. These would necessarily allow for incorporation, amendment or exclusion either in whole or part in particular individual cases as the parties desired. The objective would not be to limit party choice or the legal relevance and application of underlying domestic jurisdictions but only to create available standard sets of provisions where this was appropriate. This could reduce negotiation and contract times, lower costs and substantially increase certainty.

Countries could also consider to what extent internationally agreed intergovernmental or public international digital law related activities could be usefully set out in a treaty or convention. This may be relevant in the financial area specifically or with regard to ecommerce more generally. This may include the development of a form of “Bretton Woods III” Treaty which initiatives were discussed following the global financial crisis although subsequently aborted. This could specifically cover such matters as international payment, capital flows and monetary arrangements including clarifying the role and function of international financial institutions, such as the IMF and World Bank, in the new digital global economy. The IMF may specifically become involved in the issuance of public and private digital currencies either directly or indirectly, including through the possible use of

375. Models already exist with the international loan documentation produced by the Loan Market Association (LMA) for use in the banking area, capital market documents by the International Capital Markets Association (ICMA) and derivatives documentation by the International Swaps and Derivatives Association (ISDA). FINANCIAL MARKETS AND EXCHANGES LAW, supra note 104, at chs. 1, 2.
adjusted Special Drawing Rights (SDRs) as an international transferable
digital currency or digital reference asset (“DRA”) for other digital monetary
assets. Such a treaty could also clarify applicable Private International Law
rules and possibly recognize and give legitimacy to special Digital Dispute
Resolution mechanisms as well as cover such other matters as taxation,
money laundering and the prevention of anti-terrorist financing and
criminal activity. Other matters relevant to the effective operation and
governance of a global digital economy could also be considered for
inclusion as appropriate.

L. Financial Stability, Advantage and Benefit

The Internet creates substantial inter-connection as well as inter-
dependence and inter-exposure. New FinTech and larger digital
developments may bring substantial opportunities and benefits for specific
market operators and users, although care has to be taken to ensure that
none of this destabilizes existing financial and other markets. It is also
necessary to ensure that all potential disruption is properly monitored and
managed to the extent necessary and benefits shared to the extent
appropriate. Market authorities will specifically have to monitor the
potential build-up of latent risks and exposures as a result of FinTech
companies or activities that may threaten the stability of specific sectors or
markets.

The possibility of wider contagion must also be avoided. This will
specifically involve the inclusion of a more technology specific element
within new macro-prudential practices, such as those applied by the FSOC
in the US, the ESRB in the EU and FPC in the UK. This will create a form
of MacroTech, which will involve the oversight of more general systems
stability in addition to the more specific MicroTech review applied at the
individual firm level. For this purpose, macro-prudential bodies will have to
develop dedicated additional technical data collection and analysis
techniques to monitor such exposures and extend their cooperation and
coordination activities as necessary. The FSB has already assumed a role in
this area at the international level through the inclusion of technology and
FinTech within its ongoing review activities although a considerable amount
of is required in this area.

XI. FinTech Close

FinTech represents a highly important new area and point of
technological and financial departure. FinTech has to be considered in an
inclusive manner including both narrow external disruptors and reforming
market incumbents and all aspects of technology driven market change.
This will necessarily have a significant impact on markets, business
structures and financial services more generally. A substantial amount of
disruption will inevitably occur although much of this may only accelerate
natural business cycles and it has to be expected that many new entrants will
have to work with incumbents over time who are developing their own internal systems. Inefficient incumbents may also simply be acquired by other large legacy financial groups. FinTech may accordingly work more by absorption and assumption rather than disruption and damage.

The most significant changes will initially occur in the areas of customer interface and the quality of service provision as well as payment and digital currencies with this being extended subsequently into other fields over time. It is expected that many firms and customers will experiment with new forms of digital valuation and digital value transfer. Many users, including large value and longer term wealth holders, may nevertheless wish to remain with digital assets denominated in the form of an official reference asset and supported by domestic central banks on government for reasons of security, value and price stability.

A key new element will be the creation of whole new set of digital rights, interest, entitlements, claims and record devices that allow of the creation, holding, transfer, exercise and cancellation of financial rights safely, securely and efficiently. This will inevitably arise as a result of the conversion and transformation of underlying existing legal rights into a digital form and origination through the creation of new digital entitlements.

The developing area of RegTech will assist manage rights and obligations over time and increase the effectiveness and efficiency of firm compliance. This nevertheless only forms one part of the larger more comprehensive regulatory structure that will have to be constructed to deal with all aspects of new TechRisk and FinRisk with the creation of wider FinTech solutions and operations. The immediate challenge will be in the banking markets although there will also be significant regulatory and supervisory disruption in other areas with financial authorities having to substantially increase their technical capability, expertise and knowhow. This will also then extend into non-financial sectors and across society more generally. All of this can be considered to fall with the new emerging area of Financial Technology Law or TechLaw.

While this may lead to significant short-term disruption, it will inevitably result in substantial medium and longer-term growth and development as new innovative techniques and products are absorbed into the evolving financial system. Again, rather than consider this as part of a narrow, fixed FinTech effect, this will operate within a larger new online, Internet, and virtual web environment. FinTech is important although it will only form one part of the larger evolution of the Internet through the Value Net, Immersive, and other iterations. All of this will increase customer and business service at cheaper cost and hopefully increase market and financial liquidity and efficiency. More fundamental transformations and innovative new practices and applications may also arise. Care only has to be taken to ensure that that any new emergent risks and exposures are properly identified, managed, and contained over time. The potential and future evolution of FinTech may be highly promising indeed. Change is inevitable and unavoidable.