

Financial Stability Implications from FinTech

Supervisory and Regulatory Issues that Merit Authorities' Attention

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Table of Contents

	Page
Executive Summary	1
1. Introduction	6
2. The Framework for analysis	7
2.1 The scope of FinTech activities covered.....	7
2.2 Common drivers of FinTech innovations	10
2.3 The benefits and risks considered	12
2.4 Potential to support financial stability	13
2.5 Potential to undermine financial stability	13
3. Why FinTech is worth looking at from a financial stability perspective.....	15
3.1 Potential benefits for financial stability	16
3.2 Potential to undermine financial stability	17
3.3 Key insights on balancing financial stability implications	21
4. Supervisory and regulatory approaches to FinTech.....	23
4.1 How FinTech fits into current regulatory frameworks	24
4.2 Challenges to monitoring FinTech activities	27
5. FinTech issues that merit authorities' attention	29
5.1 Other issues that may merit authorities' attention	31
5.2 Ongoing monitoring of FinTech	32
Glossary.....	33
Annex A – Common drivers of FinTech innovations	35
Annex B – Case study on retail payments and digital wallets	38
Annex C – Case study on FinTech credit.....	40
Annex D – Case study on robo-advisors	43
Annex E – Case study on DLT-based wholesale payment systems.....	47
Annex F – Case study on private digital currencies.....	52
Annex G – Case study on AI and machine learning	55
Annex H – Stocktake of regulatory approaches to FinTech	57
Annex I – Members of the FSB FinTech Issues Group	60

Supervisory and Regulatory Issues Raised by FinTech that Merit Authorities' Attention

Executive Summary

Technology-enabled innovation in financial services (FinTech) is developing rapidly. With its emergence, there will be both opportunities and risks to financial stability that policymakers, regulators, supervisors and overseers should consider. This is particularly important as many innovations have not yet been tested through a full financial cycle, and decisions taken in this early stage may set important precedents. Policymakers should continue to assess the adequacy of their regulatory frameworks as adoption of FinTech increases, with the objective of harnessing the benefits while mitigating risks. In this regard, the German G20 Presidency, as part of its focus on digitalisation, has suggested that the Financial Stability Board (FSB) build on the monitoring to date and identify supervisory and regulatory issues of FinTech that merit authorities' attention from a financial stability perspective.

Currently, any assessment of the financial stability implications of FinTech is challenging given the limited availability of official and privately disclosed data. It will be important to take into account materiality and risks in evaluating new areas. It will also be important to understand how business models of start-ups and incumbents, and the market structure, are changing.

To draw out the supervisory and regulatory issues of FinTech, the FSB developed a framework that defines the scope of FinTech activities and identifies the potential benefits and risks to financial stability. It provides a basis on which future analysis and monitoring can be made. As most FinTech activities are currently small compared to the overall financial system, the analysis focuses on conceivable benefits and risks. Nonetheless, international bodies and national authorities should consider taking FinTech into account in their existing risk assessments and regulatory frameworks in light of its rapid evolution. Indeed, many authorities have already made regulatory changes to adapt to FinTech activities.

There are clear benefits to greater international cooperation given the commonalities and global dimension of many FinTech activities. Increased cooperation will be particularly important to mitigate the risk of fragmentation or divergence in regulatory frameworks, which could impede the development and diffusion of beneficial innovations in financial services, and limit the effectiveness of efforts to promote financial stability.

Drawing on the findings of the literature, discussions with academics and industry participants, and a stocktake of regulatory approaches to FinTech, the FSB concludes that there are currently no compelling financial stability risks from emerging FinTech innovations. The analysis identifies, however, 10 issues that merit authorities' attention, of which three are seen as priorities for international collaboration. Addressing these priority areas is seen as important to promoting financial stability, fostering responsible innovation and preventing any derailment of authorities' efforts to achieve a more inclusive financial system.

Although many of these issues are not new, they may be accentuated given the speed of growth of FinTech, new forms of interconnectedness, and increased dependencies on third-party service providers. All of the issues identified are building blocks for ensuring a strong, sustainable and resilient financial system as innovations in financial services evolve and are

adopted. The FSB will continue to monitor and discuss the evolution of the financial stability implications of FinTech developments going forward.

Priority areas for international cooperation

Areas where international bodies and national authorities should seek to increase their awareness of FinTech when undertaking regular risk assessment and development of micro- and macroprudential regulatory frameworks include:

1. ***Managing operational risks from third-party service providers.*** Authorities should determine if current oversight frameworks for important third-party service providers to financial institutions are appropriate, e.g. in cloud computing and data services, in particular if financial institutions rely on the same third-party service providers. This may entail greater coordination globally across financial authorities, and with non-traditional partners such as authorities responsible for information technology (IT) safety and security.
2. ***Mitigating cyber risks.*** Recent reports of significant and successful cyber-attacks underscore the difficulties of mitigating cyber risk. Ex ante contingency plans for cyber-attacks, information sharing, monitoring, a focus on incorporating cyber-security in the early design of systems, and financial and technology literacy could help to lower the probability of cyber events that have adverse effects on financial stability.
3. ***Monitoring macrofinancial risks.*** While there are currently no compelling signs of these risks materialising, experience shows that they can emerge quickly if left unchecked. Systemic importance and procyclicality could emerge from a number of sources, including from greater concentration in some market segments and if funding flows on FinTech lending platforms were to become large and unstable. Any assessment of the implications of FinTech for financial stability is challenged by the limited availability of both official and privately disclosed data in the FinTech area. Authorities should consider developing their own capacity to access existing and new sources of information.

Other issues that merit authorities' attention

4. ***Cross-border legal issues and regulatory arrangements.*** Innovations in cross-border lending, trading and payment transactions, including via smart contracts, raise questions about the cross-jurisdictional compatibility of national legal frameworks. The legal validity and enforceability of smart contracts and other applications of distributed ledger technology (DLT) are in some cases uncertain, and should be discussed further.
5. ***Governance and disclosure frameworks for big data analytics.*** Big data analytics are driving transformation across industries with the ability to conduct extensive analytics rapidly and enhance risk identification and assessment. Similar to the use of algorithms in other domains, such as securities trading, the complexity and opacity of some big data analytics models makes it difficult for authorities to assess the robustness of the models or new unforeseen risks in market behaviour, and to determine whether market participants are fully in control of their systems.
6. ***Assessing the regulatory perimeter and updating it on a timely basis.*** Regulators should be agile when there is a need to respond to fast changes in the FinTech space, and to implement or contribute to a process to review the regulatory perimeter regularly. This

may be more easily and efficiently achieved with an approach that is neutral with regard to technologies and based on financial service activities.

7. ***Shared learning with a diverse set of private sector parties.*** In order to support the benefits of innovation through shared learning and through greater access to information on developments, authorities should continue to improve communication channels with the private sector and to share their experiences with regulatory sandboxes, accelerators and innovation hubs, as well as other forms of interaction. Successes and challenges derived from such approaches may provide fruitful insights into new emerging regulatory engagement models.
8. ***Further developing open lines of communication across relevant authorities.*** Due to the potentially growing importance of FinTech activities and the interconnections across the financial system, authorities may wish to develop further their lines of communication to ensure preparedness.
9. ***Building staff capacity in new areas of required expertise.*** Supervisors and regulators should consider placing greater emphasis on ensuring they have the adequate resources and skill-sets to deal with FinTech.
10. ***Studying alternative configurations of digital currencies.*** The implications of alternative configurations of digital currencies for national financial systems, and the global monetary framework should be studied. In addition to monitoring developments, relevant authorities should analyse the potential implications of digital currencies for monetary policy, financial stability and the global monetary system. One issue is the use of some virtual currencies for illegal activities (including cyber-attacks).

The Framework

This report classifies FinTech innovations by their primary economic functions and activities, rather than the underlying technologies and the regulatory classification. The FSB Framework is applied to a sample of specific FinTech activities (FinTech credit, robo-advisors, wholesale payments innovations, digital currencies, artificial intelligence (AI) and machine learning) to assess potential benefits and risks to financial stability. Potential benefits include decentralisation and increased intermediation by non-financial entities; greater efficiency, transparency, competition and resilience of the financial system; and greater financial inclusion and economic growth, particularly in emerging market and developing economies. Potential risks are both microfinancial (e.g. credit risk, leverage, liquidity risk, maturity mismatch and operational risks, especially cyber and legal) and macro-financial (e.g. non-sustainable credit growth, increased interconnectedness or correlation, incentives for greater risk-taking by incumbent institutions, procyclicality, contagion and systemic importance).

The lack of data and information poses constraints to assessing the significance of the financial stability implications of FinTech. While industry and academic associations collect information on certain FinTech activities on a voluntary basis, this effort is at a nascent stage. In addition, the nature of the data needed by regulators and supervisors may be different.

There are, however, five key observations on possible implications of FinTech for financial stability. These observations consider the complementarities and trade-offs between financial stability, competition, consumer/investor protection, and financial inclusion:

1. The benefits of decentralisation and intermediation by non-financial entities may not be as prominent as some anticipate, as network effects and economies of scale and scope could foster greater concentration. For example, new credit providers could lead to a rapid rise in the systemic importance of non-traditional players.
2. Greater efficiency and better use of data could support financial stability if the associated risks are properly managed. However, increased speed in analysis and execution from the inundation of data using technology and algorithms could come at the expense of rigour in managing financial and operational risks, or heightened prospects for “fire-sales” or “flash crashes”. Greater efficiency of new players might put pressure on the profitability of incumbents and lead to increased risk-taking.
3. Some operational risks could be reduced with FinTech developments, as legacy systems are modernised and processes streamlined. Yet cyber risk, third-party dependencies and legal uncertainty could lead to new and expanded sources of operational vulnerabilities.
4. FinTech has great potential to expand access to financial services for both households and businesses. This could enhance sustainable and inclusive growth, provided that the accompanying risks are managed to maintain trust in the system and avoid a build-up of risks that could lead to financial instability.
5. The rapid pace of change makes it more difficult for authorities to monitor and respond to risks (e.g. credit, liquidity) in the financial system, unless availability of relevant data and information to assess the significance of risks from FinTech is improved.

Regulatory approaches to FinTech

The degree to which regulators will respond to FinTech activities may be a function of whether current regulatory frameworks cover relevant emerging risks. For instance, macro-financial issues related to systemic importance are embedded in the FSB policy framework for addressing systemically important financial institutions (SIFIs).¹ Some microfinancial risks of certain FinTech activities, such as credit, leverage, liquidity and maturity mismatch, may be within the FSB policy framework for strengthening oversight and regulation of shadow banking entities.²

While many FinTech activities are covered within existing regulatory frameworks, the FSB stocktake of regulatory approaches to FinTech finds that a majority of jurisdictions surveyed have already taken or plan to take regulatory measures to respond to FinTech. The scope and scale of changes or planned changes vary substantially, depending, among other things, on the relevant size and structure of domestic financial and FinTech sectors – and the flexibility provided already by the existing regulatory framework. Some regulatory authorities have recently issued publications or proposals on aspects of FinTech. Several jurisdictions have introduced regulatory sandboxes, hubs or accelerators in order to promote innovation and improve interactions with new FinTech firms. In general, the policy objectives pursued are

¹ FSB (2010), [“Reducing the Moral Hazard Posed by Systemically Important Financial Institutions” \(SIFIs\)](#), October.

² FSB (2013), [“Policy Framework for Strengthening Oversight and Regulation of Shadow Banking Entities](#),” August. The FSB defines shadow banking as “credit intermediation involving entities and activities (fully or partly) outside the regular banking system.” Some authorities and market participants prefer to use other terms such as “market-based financing” instead of “shadow banking.” The use of the term “shadow banking” is not intended to cast a pejorative tone on this system of credit intermediation. The FSB is using the term “shadow banking” as it is the most commonly employed and, in particular, has been used in previous G20 communications.

mostly consumer and investor protection, market integrity, financial inclusion and promoting innovation or competition. Financial stability was not often cited as an objective for recent or planned regulatory reforms with regard to FinTech.

1. Introduction

The FinTech landscape continues to evolve. In the first nine months of 2016, global investment in FinTech reached \$21 billion, marking a five-fold increase over 2013.³ Much of this investment is occurring in the United States (US) and in Asia, where large and successful FinTech firms operate in the payments and lending space, and new investment is going into insurance, DLT and wealth management.⁴ While there is currently limited evidence regarding risks to financial stability emanating from FinTech developments, change is occurring rapidly and decisions taken in this early stage may set important precedents. Policymakers should continue to assess the adequacy of their regulatory frameworks in an environment of increasing adoption of FinTech, with the objective of harnessing the benefits while mitigating potential financial stability risks.

The purpose of this paper is to contribute to this effort by developing a Framework to assess the FinTech landscape and identify the key supervisory and regulatory issues related to financial stability that may merit the attention of authorities. Financial stability is the foundation for solid, sustainable and inclusive growth. In this regard, this paper responds to the G20 prioritisation of digitisation issues.

The emergence of technology-enabled innovation in financial services is the result of a confluence of drivers. First, customer preferences, particularly amongst millennials and “digital natives” with regard to convenience, speed and cost of financial services are increasingly important.⁵ Other demand factors, such as those related to the forces of economic development and convergence, are driving adoption of FinTech in some rapidly growing emerging market and frontier economies. Second, evolving technology, particularly that related to the internet, big data, mobile technology, and computing power, has been a clear driver of innovations in financial services. Business opportunities have opened for new entrants that are able to scale up faster and in more cost-effective manners than established institutions, which may have inefficient legacy IT systems. Finally, business opportunities may have opened up in areas where traditional financial institutions have scaled back activities, introducing intermediation by non-traditional non-financial participants. For example, higher capital requirements and post-crisis deleveraging may have changed the lending behaviour of some banks.

The Framework to assess the FinTech landscape, articulated in Section 2, first defines the scope and high-level classification of activities that are considered, with a focus on the services provided rather than the providing entity or the technology itself.⁶ It then outlines some relevant aspects of market structure associated with the common drivers of innovation in financial services noted above. Finally, the Framework describes the categories of potential benefits and

³ Citi Global Perspectives and Solutions (2017), “[Digital Disruption – Revisited: What FinTech VC Investments Tell us About a Changing Industry](#),” January; Accenture (2016), “[Fintech and the evolving landscape: landing points for the industry](#),” April.

⁴ Ibid. Citi estimates that 60% of venture capital investment in the first nine months of 2016 went into lending, while 14% went into payments and 13% into insurance. Lending activity is growing in Asia, and insurance is larger in the US.

⁵ ‘Millennials’ are generally defined as the generational cohort born between the early 1980s and late 1990s, following ‘generation X’ (born between the mid-1960s and early 1980s) and the ‘baby boomers’ (born between the 1940s and 1960s). The often-used term ‘digital natives’ refers to those consumers who grew up with digital technologies.

⁶ In some cases, the report refers to specific private sector firms as examples. These examples are not exhaustive and do not constitute an endorsement by the FSB or its members for any firm, product or service.

risks that will be considered in the analysis. The analysis focuses on conceivable benefits and risks from a financial stability perspective – that is, on potentiality. At this juncture it is difficult to accurately gauge the probability of any particular benefit or risk materialising.

The Framework is then applied to a sample of specific areas of FinTech (Section 3 and annexes). The approach taken is symmetric, with equal attention given to channels through which FinTech adoption could reduce existing financial stability risks, rather than sole focus on new or increased risks. The approach also acknowledges that the benefits and risks of FinTech, and implications for market structure over time, may differ importantly depending on the existing degree of competition, as well as the scale, efficiency and entrenchment of incumbent financial service providers. For instance, emerging market economies may witness greater decentralisation and stronger growth in financial services that fall outside of the traditional banking sector than advanced economies as mobile banking broadens access to “unbanked” consumers.

In order to identify areas where there are new issues and areas where an existing framework may be appropriate (e.g. the FSB’s shadow banking or SIFI frameworks) for assessing and mitigating potential financial stability risks posed by FinTech, the assessment is informed by a review of the high-level architecture of current regulatory regimes (Section 4). This assessment includes main features of existing regulatory structure, and if and how authorities have adapted (or plan to adapt) their regulatory framework as a result of FinTech.

And finally, Section 5 draws together the key issues that may merit authorities’ attention from a financial stability perspective. These issues should help to inform future work on how the regulatory environment may need to adapt and under what conditions changes may be required.

2. The Framework for analysis

The Framework for analysis includes: i) the scope of FinTech to be covered, ii) the drivers of FinTech developments and iii) the types of potential benefits and risks that are considered in the analysis.

2.1 The scope of FinTech activities covered

For the purposes of this report, FinTech is defined as technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on the provision of financial services. While the broad term “FinTech” can be useful to describe a wide range of innovations, further specificity is needed for individual innovations. In this light, it is useful to classify FinTech developments by the main existing economic functions they provide. This is helpful for two reasons: first, it draws out the financial stability implications of FinTech as compared to the existing financial market structure and, second, it places the focus of analysis on the activities and outcomes rather than on the FinTech service providers or underlying technologies.

Even though it is becoming increasingly clear that the players and methods of delivery are changing rapidly, it is not evident *a priori* that FinTech will fundamentally change the essence of intermediation in the financial system or the required economic functions. Like the financial system more generally, it is useful to view these functions as ongoing efforts to reduce financial frictions. Such financial frictions may include information asymmetries, incomplete markets,

and negative externalities,⁷ and may be closely related to misaligned incentives,⁸ network effects⁹ or behavioural distortions.

Each friction entails costs for households and businesses seeking to transact with one another, which are reduced through financial intermediation. For example, the granting of a loan by a saver to a borrower necessarily involves information asymmetries ex ante (adverse selection) and ex post (moral hazard), which is less costly to manage when intermediated through a bank (or similar intermediary) that specialises in assessing risk and monitoring loans.¹⁰ Similarly, the costs of executing trades in financial markets may be prohibitively high for individual investors, and more efficient to execute through collective investment vehicles.¹¹ Finally, insurance is another example of a financial service that has arisen to deal with information asymmetries, as households and businesses try to protect themselves from the financial impact of adverse shocks.¹²

Demand for these financial services is met by an ever-evolving ecosystem of financial institutions and markets, whose institutional form varies over time and across-borders.¹³ It is well established in the economic literature that countries with a well-functioning financial system, combined with a sound legal system and enforceability of contracts, enjoy higher economic growth.¹⁴

This paper builds on previous work by organising FinTech activities into five categories of financial services: (i) payments, clearing and settlement; (ii) deposits, lending and capital raising; (iii) insurance; (iv) investment management; and (v) market support (Figure 1).¹⁵ There has been rapid growth of innovations touching all these categories of financial services, with activities at both the retail (i.e. households and small and medium enterprises (SMEs)) and wholesale (corporations, non-bank financial institutions and inter-bank) levels.

⁷ These can be on either the demand or supply side and represent costs incurred by market participants who were not party to the transaction causing the effect.

⁸ These can be associated with principal-agent problems and moral hazard leading to excessive risk-taking, herding behaviour, correlated trading strategies and mispricing of risks. See for example James W. Buchanan and Wm. Craig Stubblebine (1962), “Externality,” *Economica* 29(116): 371–84; Nicola Gennaioli, Andrei Shleifer and Robert W. Vishny (2012), “Neglected risks, financial innovation, and financial fragility,” *Journal of Financial Economics* 104: 452–468; and Markus K. Brunnermeier (2001), “Asset pricing under asymmetric information: Bubbles, crashes, technical analysis, and herding,” Oxford University Press.

⁹ See for example Jean-Charles Rochet and Jean Tirole (2003), “Platform Competition in Two-Sided Markets,” *Journal of the European Economic Association* 1(4): 990–1029.

¹⁰ Xavier Freixas and Jean-Charles Rochet (2008), *Microeconomics of Banking: Second Edition*, Cambridge and London: The MIT Press.

¹¹ Josh Lerner and Peter Tufano (2011), “The Consequences of Financial Innovation: A Counterfactual Research Agenda,” *Annual Review of Financial Economics* 3: 41–85.

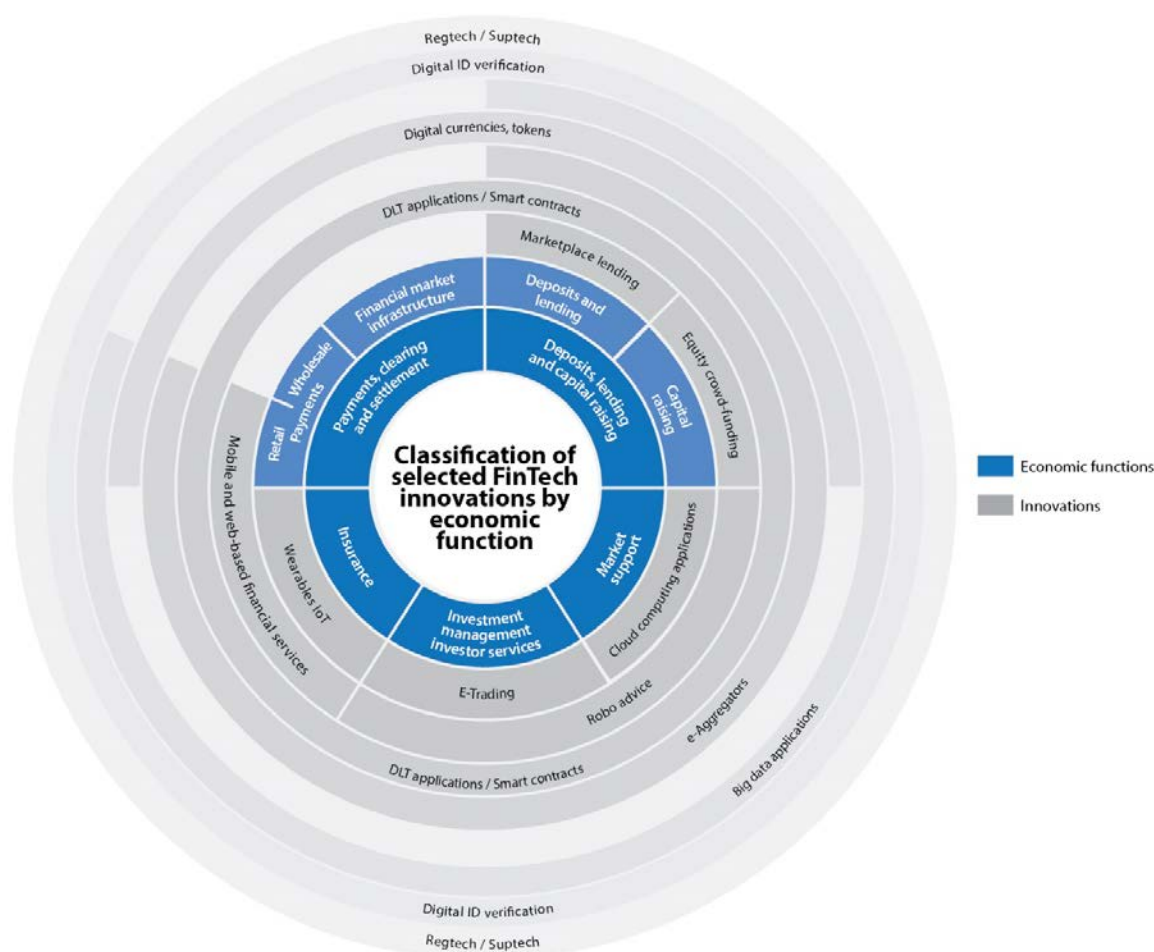
¹² Michael Rothschild and Joseph Stiglitz (1976), “Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information,” *The Quarterly Journal of Economics* 90(4): 629–649.

¹³ Robert Merton and Zvi Bodie (2005), “Design of financial systems: Towards a synthesis of function and structure,” *Journal of Investment Management* 3(1): 1–23.

¹⁴ Ross Levine (2005), “Finance and growth: theory and evidence” in Philippe Aghion and Steven Durlauf (eds.), *Handbook of Economic Growth*, Edition 1, Volume 1, Elsevier: 865–934.

¹⁵ This builds on the FSB Financial Innovation Network (FIN) work, which draws on the categorisation from World Economic Forum (June 2015), “[The Future of Financial Services](#).”

Figure 1: Stylised classification of selected FinTech innovations by economic function



In the payments space, for example, mobile and web-based payment platforms, such as Alipay, Android Pay, Apple Pay, M-Pesa, PayPal and Samsung Pay, offer end users the ability to pay for goods and services online or through handheld devices, potentially providing the ability to reduce transaction costs relative to more traditional payment methods.¹⁶ Digital currencies, such as Bitcoin and Litecoin, aim to be used for similar purposes by households and firms to pay for real economic transactions. Loans can also be granted in digital currencies. Crowdfunding, meanwhile, connects investors to borrowers (or, for equity, issuers) through an internet-based platform; this can be seen as a means to pool funds and streamline the sharing of information outside traditional financial intermediaries, although the degree of effectiveness in this regard may vary across platforms.

Across a range of economic functions, financial institutions are investigating applications for DLT – for cross-border interbank payments, credit provision, capital raising and for digital clearing and settlement. The potential gains for customers may be substantial; in the area of remittances, for example, transaction costs for sending \$200 currently average 7.4% globally.¹⁷

¹⁶ Deloitte (2014), “[Digital Transaction Banking: Opportunities & Challenges](#).”

¹⁷ World Bank (2016), “[Remittances Prices Worldwide](#),” Issue 20, December.

The ability to transfer and to record the ownership of digital assets and immutably store information are considered advantages of the technology that may help to reduce information asymmetries.¹⁸ Digital identity verification brings similar potential advantages in terms of information security, and further reduction of transaction costs.

Other innovations are seeking to change how information and services are provided to the market. Smart contracts can be used to automate transactions and business processes, thus reducing transaction costs. For instance, estimates suggest that mortgage borrowers in the US and European markets could potentially save \$480 to \$960 per loan and banks would be able to reduce costs in the range of \$3 billion to \$11 billion annually by lowering processing costs in the mortgage origination process.¹⁹ In addition, usage of smart contracts in the personal motor insurance industry alone could result in \$21 billion annual cost savings globally through automation and reduced processing overheads in claims handling.²⁰ A number of applications of big data further seek to improve credit risk assessments, investment returns or the pricing of insurance contracts, by exploiting the value of information. Finally, robo-advice and e-aggregators may seek to improve financial advice services (e.g. speed, variety and quality of financial advice) and overview of financial products available to users, again capitalising on the availability of information.

Throughout the full spectrum of financial services, internal auditors, regulators and supervisors, for example, to reduce the costs of regulatory reporting (“RegTech”) or to detect risks early on, can also use FinTech.²¹

2.2 Common drivers of FinTech innovations

Innovation in financial services is not a new phenomenon. Over the past few decades, innovations have included credit cards in the 1960s, debit cards and cash dispensing terminals such as automated teller machines (ATMs) and telephone banking in the 1970s and 1980s, and new financial products in the wake of deregulation of bond and capital markets in the 1990s. At the turn of the century, internet banking brought new benefits of branchless banking and the ability to conduct remote banking activities, which do not require face-to-face interaction between the customer and the banks. With the advent of cell or mobile devices, such technology again signalled the entrance of new participants such as mobile telephony, internet-based operators, and both hardware and software providers. With these changes came predictions that direct finance would replace costly and inefficient indirect finance and financial intermediation, and many question whether the latest wave of innovation is not simply a case of *déjà vu*.²² That said, it is too early to conclude how the market structure for financial services will evolve over

¹⁸ David Mills, Kathy Wang, Brendan Malone, Anjana Ravi, Jeff Marquardt, Clinton Chen, Anton Badev, Timothy Brezinski, Linda Fahy, Kimberley Liao, Vanessa Kargenian, Max Ellithorpe, Wendy Ng, and Maria Baird (2016), “[Distributed ledger technology in payments, clearing, and settlement](#),” Finance and Economics Discussion Series 2016-095. Washington: Board of Governors of the Federal Reserve System.

¹⁹ Bart Cant, Amol Khadikar, Antal Ruiters, Jakob Bolgen Bronebakk, Jean Coumaros, Jerome Buvat, and Abhishek Gupta (2016), “[Smart Contracts in Financial Services: Getting from Hype to Reality](#),” Capgemini Consulting.

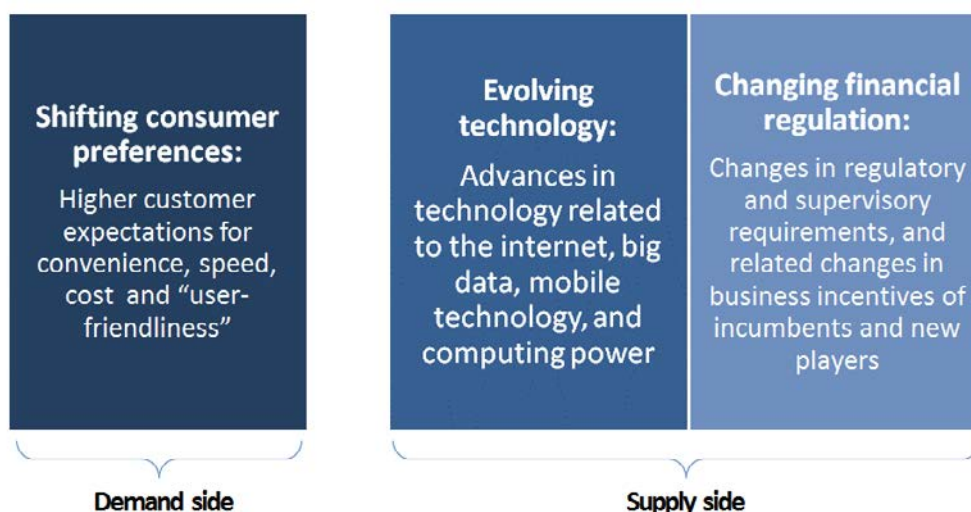
²⁰ Ibid.

²¹ Douglas W. Arner, Janos Nathan Barberis and Ross P. Buckley (2016), “[FinTech, RegTech and the Reconceptualization of Financial Regulation](#),” *Northwestern Journal of International Law & Business*.

²² Jean Dermine (2016), “[Digital banking and market disruption – a sense of déjà vu](#),” Banque de France, Financial Stability Review, No 20.

time. New service providers could be purchased by banks, or could grow to become competitors; markets could become more fragmented or more concentrated.

Figure 2: Drivers of financial innovation



There are several common and inter-related drivers of innovation in the current context that may shed light on this question:²³ shifting consumer preferences, evolving technology, and changing financial regulation (see Figure 2 and Annex A for further discussion). Any of these three drivers alone could have material implications for the structure of the financial system.²⁴ In this context, there are a number of aspects of market structure that merit consideration:

- **Concentration:** Broadly speaking, this refers to the distribution of market share among competitors offering similar services. A reduction in concentration would be associated with greater competition (setting the stage for more innovation), lower market power of individual intermediaries and hence lower prices. Concentration may be reduced if technology allows new or non-traditional service providers to compete with existing players. Such new service providers may leverage technology to unbundle services or provide goods or services that leapfrog legacy systems.
- **Contestability:** Network externalities, the importance of client trust and reputation, and fixed costs of production represent important barriers to entry, which tend to favour oligopolistic structures in the provision of financial services. Technology, however, may reduce costs for new entrants, and help to level the playing field in terms of access to technology by competing firms, which may themselves be technology leaders. As a result, the threat of competition may reduce the pricing power of incumbents.

²³ In fact, these drivers are commonly referred in the economic literature as drivers of financial innovation more generally. See for example, Jakob de Haan, Sander Oosterloo and Dirk Schoenmaker (2015), “Financial Markets and Institutions: A European Perspective,” 3rd edition, Cambridge: Cambridge University Press. For additional insights on the impact of technology and regulation on financial innovation, see Ben S. Bernanke (2009), “Financial Innovation and Consumer Protection,” speech at the Federal Reserve System's Sixth Biennial Community Affairs Research Conference, Washington, D.C., 17 April 2009; and Dan Awrey (2013), “Toward a supply-side theory of financial innovation,” *Journal of Comparative Economics* 41(2): 401–419.

²⁴ See for example, CGFS-FSB (2017), “[FinTech Credit Market Structure, business models and financial stability implications](#),” May, p. 33-35.

- **Composition:** The unbundling of financial services potentially enabled by technology may mean that new entrants, or incumbents, are better able to separate the provision of many financial services from more traditional bank activities, such as deposit taking. This could lead to a change in the composition of service providers and result in a greater share of activity falling outside of the regulatory perimeter, or potentially reduce compliance costs.

2.3 The benefits and risks considered

This paper focuses on the potential for FinTech either to support or undermine financial stability.²⁵ At the same time, it is important to highlight that there may at times be overlaps and trade-offs between financial stability concerns and other regulatory lenses. Aside from financial stability, relevant lenses for policymakers in this regard are consumer and investor protection, market integrity, competition and financial inclusion. That is also why work is going on among many different international organisations, committees, working groups and standard-setting bodies (SSBs).²⁶ Coordination and cooperation to avoid duplication of work and reap synergies from the various efforts at the international level is therefore vital.

The functional perspective introduced in Section 2.1 provides a way to analyse underlying financial frictions that are specific to or cut across the economic functions performed. This can be used to analyse the benefits and risks of technologically driven financial innovation. For instance, some innovations could lead to a more efficient provision of financial services while, ideally, also reducing frictions. Alternatively, systemic risks and hence financial stability concerns (as well as concerns from the other lenses cited above) due to existing frictions may be exacerbated or new ones may be introduced; for example, if innovations lead to greater or new imbalances and contagion channels. Indirect network effects in two-sided platform-based models may additionally give rise to asymmetric pricing strategies benefitting one side of the market more strongly.²⁷

²⁵ Frequent data and endogeneity problems mean that there is only a slim body of empirical literature on the way financial innovations affect financial stability. For a higher level of financial innovation, evidence of positive growth effects, but also higher idiosyncratic bank fragility, can be found in Thorsten Beck, Tao Chen, Chen Lin and Frank M. Song (2014), “Financial innovation: the bright and the dark sides,” *Journal of Banking & Finance* 72: 28–51.

²⁶ These include, among others, the Basel Committee on Banking Supervision (BCBS), the Committee on the Global Financial System (CGFS), the Committee on Payments and Market Infrastructures (CPMI), the Global Partnership for Financial Inclusion (GPFI), the International Association of Insurance Supervisors (IAIS), the International Organization of Securities Commissions (IOSCO) and the Organisation for Economic Co-operation and Development (OECD).

²⁷ Platform-based FinTech models match different sets of customers (e.g. borrowers and creditors or savers and issuers in the case of financial intermediation) providing a (digitally implemented) forum where the two market sides can interact. This may reduce transactions costs and information asymmetries. However, indirect network effects between the two market sides may create incentives to set below-cost prices to one market side in order to reach a certain volume of transactions and/or maximise profits. For examples from different sets of markets, see David S. Evans and Richard Schmalensee (2007), “The industrial organisation of markets with two-sided platforms,” *Competition Policy International* 3 (1) 2007.

2.4 Potential to support financial stability

Technology-enabled innovation in financial services, in theory, yields benefits for economic growth and financial stability through many transmission channels, including by reducing some of the financial frictions noted earlier.²⁸ These are summarised in Figure 3.

Figure 3: Main benefits to financial stability

Potential benefit	Link to financial stability
Decentralisation and diversification	Decentralisation and diversification in the financial system can dampen the effects of financial shocks in some circumstances. ²⁹ Failure of a single (or type of) institution is less likely to shut down a market as there would be other (types of) providers of financial services.
Efficiency	Efficiency in operations, including through incentives created by contestability, ³⁰ supports stable business models of financial institutions and contributes to overall efficiency gains in the financial system and the real economy.
Transparency	Transparency reduces information asymmetries and enables risks to be more accurately assessed and better priced. ³¹ It can further foster the creation of financial instruments with exposure to specific risks, completing markets and improving market participants' ability to manage risk.
Access to, and convenience of, financial services	Access to, and convenience of, financial services affects the financial inclusion of households and businesses, including SMEs. This is important for supporting sustainable economic growth and providing a diversification of exposure to investment risk.

2.5 Potential to undermine financial stability

In the years following the global financial crisis, international organisations have been developing various frameworks to assess the risks to financial stability arising from most or all of the economic functions outlined in Section 2.1. The potential for FinTech to undermine financial stability can therefore be assessed by drawing upon the key characteristics of each of these frameworks. The two components to this approach are microfinancial risks and macro-financial risks, including key transmission channels.

²⁸ FinTech innovations may also result in other benefits that are less directly related to financial stability that are not addressed in this report.

²⁹ See for example, Christian E. Weller and Ghazal Mir Zulfiqar (2013), "Financial Market Diversity and Macroeconomic Stability," University of Massachusetts PERI working paper. The authors find that, for developing economies, financial market diversity matters for economic stability for most periods and for most regions.

³⁰ William J. Baumol, John C. Panzar and Robert D. Willig (1982), "Contestable markets and the theory of industry structure," Rochester and New York: Saunders College Publishing/Harcourt Brace Jovanovich.

³¹ The opacity of securitisations, another example of financial innovation from recent decades, was blamed by many observers to be one of the main sources of problems that led to the 2008 financial crisis. Both the EU and the US have recently adopted regulations to require more asset-level transparency for many types of asset-backed securities. It has been shown that loans originated under the new EU transparency regime are of better quality with a lower default probability, a lower delinquent amount, fewer days in delinquency, and lower losses upon default. See A. Ertan, M. Loumioti, and R. Wittenberg-Moerman (2017), "Enhancing Loan Quality through Transparency: Evidence from the European Central Bank Loan Level Reporting Initiative," *Journal of Accounting Research*, forthcoming.

Microfinancial risks are those that make individual firms, financial market infrastructures (FMIs) or sectors particularly vulnerable to shocks. The crystallisation of such risks could have a systemic impact on the financial system if it triggers firm or sector-wide distress, with possible knock-on implications for either the provision of critical functions or services, or systemically important markets or counterparties (Figure 4).

Figure 4: Microfinancial risks

Potential risk	Link to financial stability
Financial sources	
Maturity mismatch	Occurs when a loan is extended for a longer period than the financing is contracted for, creating rollover risk. Systemic impacts could arise if the sector provides critical functions or services.
Liquidity mismatch	Arises when assets and liabilities have different liquidity characteristics, resulting in “run risk” and the need to liquidate quickly relatively illiquid assets (fire sale), disrupting markets.
Leverage	Higher leverage implies less equity available to absorb any losses materialising from the realisation of market, credit, or other risks. Potentially exposes systemically important counterparties to losses.
Operational sources	
Governance/ process control	Poor governance or process control can lead to increased risk of direct disruption in provision of financial services or critical infrastructure.
Cyber risks	The susceptibility of financial activity to cyber-attack is likely to be higher the more the systems of different institutions are connected.
Third-party reliance	Systemic risks may arise when systemically important institutions or markets are reliant on the same third parties.
Legal/ regulatory risk	Legal/regulatory risk may be greater when activities are evolving, or where regulatory arbitrage is sought. Uncertainty around liability for losses may be particularly damaging to confidence in the system.
Business risk of critical FMIs³²	FMIs may be vulnerable to external factors that could adversely impact its balance sheet, and, consequently, lead to a withdrawal of financial services, impairing its function as a critical infrastructure.

Macro-financial risks are system-wide vulnerabilities that can amplify shocks to the financial system and thereby raise the likelihood of financial instability. These risks are largely related to the interactions between firms, investors and clients that can create important transmission channels. A number of common macro-financial risks have been identified by authorities, which can potentially be applied to activities classified as FinTech. These include contagion, procyclicality, excess volatility, and entities that are systemically important (Figure 5).

³² See CPMI-IOSCO (2012), “[Principles for Financial Market Infrastructures](#)” (PFMI), Principle 15 for a discussion of this risk type and its relevance.

Figure 5: Macro-financial risks

Potential risk	Link to financial stability
Contagion	Distress experienced by a single financial institution or sector can be transmitted to other institutions or sectors – owing either to direct exposures between them, or commonalities that lead to a general loss of confidence in those institutions or sectors.
Procyclicality	Market participants can act in a way that exacerbates the degree and impact of fluctuations in economic growth and market prices over the short and/or longer term. Examples include: the excess provision of credit by banks during upswings in the economy, and the extreme degree of deleveraging that tends to take place once the economy turns into a downswing and capital positions are threatened; the low pricing of risk in financial markets during good times, and the high risk premia demanded by investors during bad times.
Excess volatility	The financial system can overreact to news. This can lead to adverse outcomes if, for example, any such overreaction creates solvency or liquidity problems that can spiral through the financial system, impairing the functioning of asset and credit markets. This is most likely to occur when there is homogeneity of business models or common exposures.
Systemic importance	Entities that are viewed as being systemically important (or too highly connected to fail) may amplify risks through moral hazard. For example, they may be more inclined to take on excessive risk, given that the downside to doing so may be limited by the implicit guarantee of public support. Predatory pricing of services could also stifle competition (“the winner takes all”), reducing the likelihood of other service providers stepping in when the entity suffers distress.

3. Why FinTech is worth looking at from a financial stability perspective

In order to identify the potential implications of FinTech for financial stability, an assessment of the potential benefits and risks is conducted for selected examples of financial services across a range of economic functions identified in Section 2. These candidate technologies focus on services that are already showing relatively high activity or are growing quickly, or may have implications for systems that are core to the financial system. They include: (i) retail payments, (ii) FinTech credit, (iii) robo-advisors, (iv) DLT-based wholesale payments systems, (v) privately-issued digital currencies, and (vi) AI and machine learning. Detailed assessments for each are included in Annexes B to G.³³

A general observation is that there is a dearth of data to assess the financial stability implications of the candidate technologies, their applications and the resulting business models. This is not only because the time series is short, but also because there are limited mechanisms (including within regulatory frameworks) to collect relevant activity and risk-related information.³⁴

³³ The case studies included in these annexes use the framework presented in the report to analyse potential financial stability issues that may be relevant to categories of FinTech. The case studies identify some risks that could arise should these categories of FinTech grow to the point where they could pose implications to financial stability.

³⁴ Among other complications for empirical assessment of the effect of financial innovations on financial stability is the problem of difficulty in defining the term “financial stability” and its quantitative measure. See for example, G. J. Schinasi,

However, several industry and academic associations are starting to collect information on certain FinTech activities.³⁵ Analysis to date suggests that FinTech developments are small but growing fast. This observation is generally consistent with work from other international organisations.³⁶

Looking forward, as FinTech developments mature, there are a number of potential important implications for financial stability that can be drawn from the analysis. Potential benefits and risks are outlined in Sections 3.1 and 3.2 respectively. Section 3.3 attempts to draw out the main insights from the analysis and discusses trade-offs in areas that are considered most important. For policymakers, the financial stability perspective can be brought to bear in conjunction with non-financial stability perspectives.

3.1 Potential benefits for financial stability

The case studies show that there could be important dimensions along which potential financial stability risks could be mitigated by some FinTech innovations. In many cases, this is because either change in market structure could occur or financial frictions could be reduced. The main observations that can be drawn from the case studies include:

- ***Decentralisation and diversification.*** FinTech may lead to greater decentralisation and diversification in a number of areas. In lending, technological advances, such as big data processing and automation of loan originations, have reduced barriers to entry. Some business models in this space may also be benefiting from lighter regulation associated with the unbundling of lending from deposits. Another example would be robo-advice, where smaller firms can operate alongside bigger firms given relatively low barriers to entry, including fixed costs. In general, decentralisation is less evident in areas with strong network externalities, such as payments and settlements. The application of DLT could, in theory, reduce concentration in the settlement process. Meanwhile, based on current experience and expectations, the likelihood of private digital currencies, such as Bitcoin or Litecoin, replacing national currencies seems to be very low.
- ***Efficiency.*** Innovations in financial services have the potential to lead to greater efficiencies. Adoption of productivity enhancing technologies, such as robo-advice, RegTech or applications of technology that streamline back-office functions, could strengthen business models of incumbent financial institutions. Machine learning and AI could facilitate improvements in decision-making processes, by improving the models that financial institutions and investors use. The business models of marketplace lenders and robo-advisors have less need for a physical presence than banks, and the use of algorithms to assess creditworthiness and investment

2004, “Defining Financial Stability,” IMF Working Paper WP/04/187. However, there is evidence of the positive effect of financial innovations on economic growth. See Thorsten Beck, Tao Chen, Chen Lin and Frank M. Song (2016), “Financial Innovation: The Bright and the Dark sides,” *Journal of Banking and Finance* 72: 28–51. See also Robert C. Merton (1992), “Financial innovation and economic performance,” *Journal of Applied Corporate Finance* 4(4) 12–22.

³⁵ For instance, the Cambridge Centre for Alternative Finance (CCAF) has conducted academic benchmarking studies of alternative credit in Europe, the Americas, Asia-Pacific and East Africa, the Peer-2-Peer Finance Association (at <http://p2pfa.info/about-p2p-finance>) collects information on P2P entities in the UK and AltFi (at <http://www.altfi.com/>) collects information on alternative finance entities in Europe, United Kingdom and the United States.

³⁶ IOSCO (2017), “[Research Report on Financial Technologies \(Fintech\)](#),” February.

opportunities appears to allow platforms to operate with relatively low costs. FinTech lending platforms could also reduce search and transaction costs and lead to better allocation of capital. Greater efficiency and speed in transaction execution promised by distributed ledgers could reduce risks by decreasing settlement time, thereby reducing the time during which one counterparty is exposed to another. Furthermore, if greater settlement speeds can free up collateral and capital for other productive uses, the financial system and the broader macroeconomy should also benefit.

- **Transparency.** Increased and better uses of data have the potential to reduce information asymmetries in many areas of FinTech. Better data could also allow for the creation of smart contracts that more accurately target specific risks users wish to manage. FinTech lending and equity crowdfunding could further complete markets for both households and businesses (e.g. SMEs).
- **Access to, and convenience of, financial services.** Clearly, the potential for improved access to a range of financial services across all of the economic functions is the greatest for regions where there are currently a large unbanked population, and where the financial system is in early stages of development. In many such jurisdictions, the share of cell phone ownership equals or exceeds the share of the population with access to a bank account, particularly in rural areas with little or no access to physical banks. Mobile banking allows consumers to quickly and efficiently obtain credit and make purchases. Innovations such as digital identity and DLT-based applications could support improved quality and accessibility of, or financial services for, end-users. More generally, robo-advisory services increase access to wealth management for households who could not access similar traditional asset management services due to, for instance, minimum investment thresholds or high fees. Innovations in insurance (e.g. InsurTech) are also increasing the range of insurance products for a wider range of customers.³⁷ Moreover, there is a potential with the evolving payments ecosystem to expand access to wholesale payments systems to non-bank entities.³⁸

3.2 Potential to undermine financial stability

Alongside these benefits, FinTech innovations can potentially have an adverse systemic impact on the financial system, although there is no evidence of such an impact at present. An adverse systemic impact implies a risk to the provision of critical financial services. A major disturbance in these services, or a disintermediation of regulated entities providing them, can have potentially serious negative consequences for the real economy. The case studies point to a number of transmission channels relevant to financial stability.

3.2.1 Microfinancial risks (vulnerabilities)

As outlined in the Framework, the microfinancial risks considered fall into two broad categories: financial risk and non-financial – or operational – risk.

³⁷ IAIS (2017), "[FinTech Developments in the Insurance Industry](#)," February.

³⁸ See for example, Faster Payments (2015), "[Faster Payments New Access Model](#)," May.

Financial risk

In the current context in which the drivers of innovation are facilitating rapid growth of the FinTech industry, firms may develop without the necessary risk management expertise and under-estimate the level of risk they are taking on. As a result, depending on their business model, they may be particularly vulnerable to different forms of financial risk. The case studies revealed some nuances depending on the type of activity and the business model used, as well as on how these characteristics could evolve over time:

- ***Maturity mismatch:*** FinTech lending is the main FinTech activity for which maturity mismatch is relevant. Typically, loans are extended and maturity matched although investors can sometimes sell their loans before maturity if other investors are willing to buy them. Also, some platforms offer a “sell-out” option for their fixed-term accounts for a fee. An outstanding question is how business models could evolve if the industry continues its current rate of expansion. For example, maturity mismatches could arise through securitisation or if lending platforms were to start using their own balance sheet to intermediate funds.
- ***Liquidity mismatch:*** Currently, FinTech activities do not typically involve the holding of client monies. For example, providers of cross-jurisdictional digital wallets tend to pull payments from bank accounts or credit card accounts. Those that do hold client monies typically invest the funds in liquid assets, such as bank deposits or government bonds, as required by “e-money” regulations. As a result, most FinTech credit platforms do not perform liquidity transformation.
- ***Leverage:*** Leverage is not typically associated with FinTech activities in their current form, but there are some cases where it could arise temporarily at least. For example, in some cases, FinTech business and consumer lending or equity crowdfunding platforms may borrow funds in order to finance temporary holdings (or “warehousing”) of bond or equity issuance. A small proportion of FinTech credit platforms engage in leverage when they use their own balance sheet to fund loans.

Operational risk

All businesses are subject to operational risk, which can arise from information systems, human error, management failures and external influences. FinTech may have the potential to accentuate a number of key areas of vulnerability and related risks, including:

- ***Governance/process control:*** Entities that offer financial services but fall outside the regulatory perimeter or are subject to lower regulatory or supervisory standards, such as some third parties offering services to regulated financial institutions, may not be subject to the same level of oversight or scrutiny of their governance and business processes to which regulated financial institutions are subject. This could become a risk to the financial system as these entities grow. Private digital currencies, for example, are effective only if the incentive structure built into their design supports exchange in an environment where participants do not trust each other. These incentive structures have performed reasonably well to date but they have only been tested in a

limited set of circumstances. There is a risk that a digital currency environment is introduced with an unstable design that is not initially apparent.³⁹

- **Cyber risks:** Cyber-attacks are a growing threat to the entire financial system, and FinTech could serve to accentuate this risk. The susceptibility of financial activity to cyber-attacks is likely to be higher the more the systems of different institutions are connected, amongst which there is a weak link (e.g. the incident involving the Bangladesh central bank through their internal connection to the SWIFT network). In general, greater use of technology and digital solutions expand the range and number of entry points cyber hackers might target. In this regard, some FinTech activities may spread data across a larger number of institutions, for example, via increased use of digital wallets and e-aggregators. However, depending on how FinTech services develop, a larger number of financial service providers could also help to increase competition and diversity in the financial system and make any single cyber-attack less systemically relevant.
- **Third-party reliance:** Some FinTech activities could increase third-party reliance within the financial system. For example, cloud computing services could be provided by a limited number of parties, which could have significant implications for a range of cloud-based financial services in the event of operational issues. Disruptions to these types of third-party services – perhaps due to operational difficulties – are more likely to pose systemic risks the more central these third parties are in linking together multiple systemically important institutions or markets.⁴⁰ For instance, robo-advice and FinTech lending may rely on a set of third-party data providers that could be highly concentrated. As in the case of retail payments, the third parties may not themselves be traditional financial institutions (e.g. telecommunications).
- **Legal/regulatory risk:** To the extent that FinTech activities are innovative and are not covered by existing legislation, legal and regulatory frameworks may need to adapt. This could apply across the full range of services, from customer interfaces to back-office systems and infrastructure. For instance, in some jurisdictions, there are issues of legal uncertainty related to FinTech innovations such as smart contracts or robo-advisors. These and other legal issues could be even more prevalent when considering cross-border activities. For example, blockchain has raised questions, such as data privacy concerns across jurisdictions, and identifying the location of an asset when no one bank or entity is the custodian of the record.
- **Business risk of critical FMIs:** Should innovative payment and settlement services grow into critical FMIs, general business losses have the potential to impair the provision of critical services and interfere with recovery or an orderly wind down. Some of these critical services may be provided by a parent company with other

³⁹ As an example, DAO had raised the equivalent of \$150 million in funding in the cryptocurrency Ethereum when it was subject to a \$50 million hack. DAO was subsequently shut down, and funds returned to investors. See Paul Vigna, “[Fund Based on Digital Currency Ethereum to Wind Down After Alleged Hack](#),” Wall Street Journal, 17 June 2016.

⁴⁰ Jeffrey Dastin (2017), “[Disruption in Amazon’s cloud service ripples through internet](#),” Reuters, February.

business lines, such as technology or data aggregation, which may sometimes conflict with the offering of financial services.⁴¹

3.2.2 *Macro-financial risks (amplifiers)*

The case studies show that certain innovations have the potential, over time, to introduce macro-financial risks that could amplify shocks to the financial system and may raise the likelihood of financial instability. As with the microfinancial risks, the extent to which each source of macro-financial risk is relevant depends on the type of financial innovation and how it might develop over time.

- **Contagion:** Reputational contagion is a potential concern for FinTech, particularly where activities interact directly with households and businesses. For example, significant and unexpected losses incurred on a single FinTech lending platform could be interpreted as indicating potential losses across the sector. Increased access, combined with risks like cyber risk that suffer from weak link problems, may also increase contagion risk. As FinTech firms seek to further reduce their cost base with automation and the use of AI, a lack of human supervision may entail new risks. For example, greater automation in trading strategies (more sophisticated algorithmic trading, social trading, etc.) may lead to new and unpredictable sources of contagion in financial markets.⁴²
- **Procyclicality:** A number of FinTech activities could be prone to procyclical dynamics. For example, interaction between investors and borrowers on FinTech lending platforms could potentially exhibit larger swings in sentiment than traditional intermediation of funds as a sudden unexpected rise in non-performing loans could trigger a drying up of new funds. The presence of retail investors could exacerbate this point even further. Social trading and robo-advice could potentially exhibit greater herding behaviour than traditional portfolio allocation methods – for example, if risk models are highly correlated due to reliance on similar algorithms – thereby potentially increasing the amplitude of swings in asset prices. Increased access to cheap debt and equity financing may also enable some entrants to actively under-price risk while competing with incumbents and this may be exacerbated by incentive problems or network effects. If such entrants and their investors are able to bear that risk for an extended period of time, this may in turn, induce incumbents to compete at lower prices/compensation for risk and increase risk-taking. Finally, in some circumstances, equity crowdfunding portals and FinTech credit intermediaries might have limited incentives to accurately assess credit quality or maintaining lending standards. All of this could increase procyclicality in the provision of those financial services, and further amplify shocks to the financial system when they arise.
- **Excess volatility:** By construction, a number of FinTech activities are designed to be fast in nature, which may mean they are more likely to create or exacerbate excess volatility in the system. For example, algorithmic traders may tend to be more active during periods of low volatility but rapidly withdraw from the market during periods

⁴¹ Many of these risks are covered in the CPMI-IOSCO PFMI (2012).

⁴² Andrei A. Kirilenko and Andrew W. Lo (2013), “Moore’s Law versus Murphy’s Law: Algorithmic Trading and Its Discontents,” *Journal of Economic Perspectives* 27(2): 51–72.

of market stress when liquidity demands are high, and thereby increase asset price volatility. Aggregators, meanwhile, are designed to facilitate the fast movement of cash around the banking system, according to changes in prices and relative performance. While this may provide better value for the customer, it could increase the volatility of bank deposits, with implications for banks' liquidity positions. More generally, in more competitive environments, an increase in the speed and ease of switching between service providers could potentially make the financial system more excessively sensitive to news.

- **Systemic importance:** In the context of FinTech, it is possible that highly connected entities emerge in the future, most likely in the form of market infrastructure. For example, DLT has a wide range of possible applications, including playing a central role in the clearing and settlement of securities. In part, this could replace existing risks associated with custody banking and central counterparties (CCPs). Digital currencies and wallets could themselves displace traditional bank-based payment systems, while aggregators could become the default means of accessing banks and applying for new bank accounts and loans. Other oligopolies or monopolies may also emerge, for example, in the collection and use of customer information, which is essential for providing financial services.

3.3 Key insights on balancing financial stability implications

The numerous possible benefits and risks need to be evaluated and weighed against one another in order to identify potential implications of FinTech developments for financial stability. In general, the significance of benefits and risks depends on the drivers and inherent market structure in which the activity is conducted, as well as the trade-offs that may be inherent in innovation. Moreover, as in the early days of the internet, how the financial system will evolve as a result of innovation is uncertain at this juncture. That said there are a number of key general observations that are worth highlighting with respect to possible implications of FinTech for financial stability:

1. ***The potential benefits associated with decentralisation and diversification may not be as prominent as some anticipate, as network effects and economies of scale and scope could foster greater concentration. In a number of areas, this could lead to a rise in the systemic importance of non-traditional players, which could undermine the resilience of the system and its ability to recover from stress events.***

The opportunity for a more decentralised market structure may be greater in emerging market and developing economies with fewer trusted incumbents. As noted in Section 3.1, decentralisation is less evident in areas with strong network externalities, such as payments and settlements. Even in areas where decentralisation and diversification are increasing (such as lending and robo-advice) the forces of economies of scale, including network effects, are likely to reassert themselves and eventually lead to consolidation. Moreover, even in areas where a decentralised, peer-to-peer approach is possible, there will likely be a need for accompanying services in the ecosystem (e.g. exchanges in the case of digital currencies, and platform providers in the case of FinTech lending). These services are often highly concentrated, even if there are new entrants in the financial sector. High concentration or newly developed critical dependencies may be the natural

and most efficient market structure (see Section 3.2.2), along with the risks this may entail. New players may not internalise negative externalities that arise should they come under stress. This underscores the importance of resiliency and frameworks to successfully recover critical functions or resolve entities should problems arise. It also underscores the importance of having the appropriate data and metrics to assess systemic importance.

2. ***The combination of greater efficiency and better use of data could provide important support to financial stability if the associated risks are properly managed, particularly those related to procyclicality and excess volatility.***

The returns to improving the quality and accessibility of information to financial system participants and regulators could be substantial (see Section 3.1). That said, increased efficiency in some cases could come at the expense of rigour in processes to manage financial and operational risks. For example, without the benefit of a full credit cycle, it is too early to say how new models that exploit big data will perform in terms of measuring and pricing risk. By enabling increased competition or contestability of markets, increased efficiency and better use of data could also lead to procyclicality and excess volatility in the financial system (see Section 3.2.2).

3. ***Some operational risks could be reduced with FinTech developments, as legacy systems are modernised and processes are streamlined. At the same time, cyber risks, third-party dependencies, and legal uncertainty could lead to new sources of operational vulnerability and channels of contagion.***

FinTech could help to reduce operational risks by streamlining processes. For instance, RegTech is helping firms to automate the more mundane compliance tasks and reduce operational risks associated with meeting compliance and reporting obligations. In addition, many firms are experimenting with AI, blockchain, and predictive data analytics to secure banking data and reduce operational risk.⁴³ Cloud computing could provide greater security than some existing, and dated, on-premises infrastructures that operate behind firewalls.⁴⁴ More generally, operational risks associated with maintaining old legacy systems could become greater than the possible risks posed by new technologies. That said, recent instances of cyber-attacks underscore the difficulty of eliminating this risk and the importance of recovery plans. FinTech innovations are often vulnerable to cyber risks, and risks arising from reliance on third-party services, and legal uncertainties (see Section 3.2.1). Such vulnerabilities could lead to channels of contagion (see Section 3.2.2) if, for example, confidence is undermined. In some jurisdictions, the fiduciary responsibilities of a FinTech company offering financial services, especially when offered at arms-length like FinTech lending and robo-advice platforms, may need to be clarified so that users can have confidence in the financial products and services they buy.

4. ***FinTech has great potential to expand access to financial services for both households and businesses.*** This could enhance sustainable and inclusive growth, provided that the

⁴³ Cutover (2017), "[Banks must embrace innovation to reduce risk](#)," January.

⁴⁴ Information Age (2015), "[The great IT myth: is cloud really less secure than on-premise?](#)" March.

accompanying risks are managed to maintain trust in the system and to avoid a build-up of risks that could lead to financial instability.

There is some evidence that some financial innovations have already led to increased access of households and businesses to financial services, particularly in emerging markets, through innovations like mobile payments.⁴⁵ Other innovations are providing services that are complementary to those provided by traditional players (e.g. market-based lending in some cases).⁴⁶ There likely remains considerable potential to increase access further, including in areas like direct access to core payments systems (noting that in many cases existing constraints are unrelated to technology). All else being equal, the increased access of these innovations should have benefits for economic growth.⁴⁷ At the same time, one of the lessons from the financial crisis of 2007/08 was that increased access to credit, while yielding short-run benefits to some households and businesses, could lead to financial instability over time and could impose costs on the financial system as a whole. This underscores the importance of monitoring the micro- and macro-financial risks that are discussed in Sections 3.1 and 3.2. Importantly, as access expands, the importance of financial literacy also increases. The case studies reveal that monitoring risks will be difficult because of important data gaps.

5. ***The rapid pace of change makes it more difficult for authorities to monitor and respond to risks (e.g. credit, liquidity) in the financial system, unless availability of relevant data and information to assess the significance of risks from FinTech is improved.***

The speed of change could, in and of itself, pose risks to financial stability as firms seek to protect or grow their businesses. In a rapidly changing environment, businesses may face pressures to take on more risk, and potentially without it being properly priced. These pressures may also be felt by incumbents in the financial system, such as banks that are facing stiff competition for particularly profitable business lines (e.g. payments, data). In addition, the rapid pace of change makes it more difficult for authorities to monitor and respond to risks in the financial system, especially given the paucity of relevant data and indicators needed to assess the materiality of risks from FinTech.

Whether these observations may be helpful to regulators is a question of how they are dealt with in current regulatory frameworks. This is discussed in the next section.

4. Supervisory and regulatory approaches to FinTech

The next step of the analysis was to assess the current regulatory architecture around FinTech. This assessment was informed by a stocktake of authorities' existing and evolving regulatory approaches to FinTech activities (see Annex H), a joint BCBS and FSB survey on supervisory

⁴⁵ Simplice A. Asongu (2013), "How has Mobile Phone Penetration Stimulated Financial Development in Africa?" *Journal of African Business* 14(1): 7-18. Asongu notes that the impact depends on the measure being used for financial inclusion.

⁴⁶ Calebe de Roure, Lorian Pelizzon and Paolo Tasca (2016), "[How Does P2P Lending Fit Into the Consumer Credit Market?](#)" Deutsche Bundesbank Discussion Paper No. 30/2016.

⁴⁷ The literature on financial inclusion generally finds a positive association with growth, particularly for forms of inclusion other than access to credit. See Ratna Sahay, Martin Čihák, Papa N'Diaye, Adolfo Barajas, Srobona Mitra, Annette Kyobe, Yen Nian Mooi and Seyed Reza Yousefi (2015), "[Financial Inclusion: Can It Meet Multiple Macroeconomic Goals?](#)" IMF Staff Discussion Note 15/17.

approaches to FinTech, and a FSB roundtable with authorities. The analysis also draws on the relevant work by the CPMI, the IAIS and the IOSCO.

In general, the policy objectives pursued by national authorities so far are mostly consumer and investor protection, market integrity, financial inclusion and promoting innovation or competition. Financial stability is not often cited as an objective for recent or planned regulatory reforms for FinTech.

The following sections describe: (1) how FinTech activities fit into current regulatory frameworks, including the findings from the stocktake of member authorities' approaches to FinTech; and (2) the challenges posed by FinTech activities for regulators and supervisors.

4.1 How FinTech fits into current regulatory frameworks

Macro-financial issues related to systemic importance are embedded in the FSB SIFI framework,⁴⁸ which recommends that financial institutions identified as systemically important should have more intense supervisory oversight, higher loss absorbency, as well as recovery and resolution plans. This is intended to reduce the probability and impact of their failure on the financial system. Meanwhile, some microfinancial risks of FinTech activities, such as credit, leverage, liquidity and maturity mismatch, may fall within the FSB shadow banking policy framework.⁴⁹ This framework consists of five economic functions or activities that focus on credit intermediation activities by non-bank financial entities that are close in nature to activities in the traditional banking sector (i.e. credit intermediation that involves maturity/liquidity transformation, leverage and/or credit risk transfer).

The SSBs have also issued guidelines and standards for the financial sector that are relevant for FinTech. For example, the Basel Committee's Core Principles are relevant for assessing innovations in banking and the interaction between banks and FinTech firms; the IOSCO Objectives and Principles are relevant for applications of FinTech in securities markets; the IAIS Insurance Core Principles are relevant for the range of FinTech applications in insurance (InsurTech); and the CPMI-IOSCO PFMI are relevant to FinTech applications in payments, clearing and settlement.⁵⁰

While many FinTech activities are covered within existing regulatory frameworks, the FSB stocktake of regulatory approaches to FinTech finds that a majority of jurisdictions (20 of 26) have already taken or plan to take regulatory measures to respond to FinTech, but the scope and scale of changes or planned changes vary substantially (see Annex H for details). These changes depend, among other things, on the relevant size and structure of domestic financial and FinTech sectors as well as the flexibility and scope of existing frameworks. Regulatory changes range from an entirely new Draft Law in Mexico and eight new sets of rules or opinions in China, to more limited amendments to existing rules or laws in the EU, Korea, Russia, Switzerland, Turkey and the United Kingdom (UK). Moreover, authorities in Argentina, Hong Kong, India, Indonesia, and Pakistan have issued specific rules or frameworks relating to

⁴⁸ FSB (2010).

⁴⁹ FSB (2013).

⁵⁰ BCBS (2012), "[Core principles for effective banking supervision](#)," September; IOSCO (2010), "[Objectives and Principles of Securities Regulation](#)," June; IAIS (2015), "[Insurance core principles](#)," November; CPMI (2012), "[Principles for Financial Market Infrastructures](#)," April.

different FinTech activities. Meanwhile, individual regulatory authorities in Canada, Germany and the US have recently issued publications or proposals on aspects of FinTech. Several jurisdictions have introduced regulatory sandboxes, accelerators and innovation hubs, as well as other forms of interaction, in order to promote innovation and improve interactions with new FinTech firms. Saudi Arabia has concluded that significant changes are not needed at this time.

The range of regulatory changes to account for specific FinTech activities, primarily based on responses to the FSB stocktake, are highlighted below under the umbrella of the economic functions described in Section 2 (as illustrated in Figure 1). The majority of regulatory changes and clarifications have been made in the areas of payments, capital raising, and to a lesser extent investment management as many of these economic functions naturally fit within existing regulatory regimes. Only a few regulatory changes to include FinTech innovations in insurance and market support were mentioned.

4.1.1 Payments, clearing and settlement

Most jurisdictions⁵¹ have issued new rules or plan to issue regulations covering mobile payments, non-bank payments and digital currencies that aim to increase financial inclusion and ensure greater consumer access to payment services, and to ensure a smooth functioning of the payments systems, in line with existing responsibilities for payments infrastructure. The EU has opened the market of payment services to non-bank providers by introducing in 2007 a tailored regulatory framework for payment institutions. For digital currencies, there are moves to clarify the legal framework for storing or transferring value and addressing risks of fraud, money laundering and terrorism financing. Japan, for example, amended its Payment Services Act to establish a regulatory framework for virtual currencies, which addresses money laundering risks arising from virtual currencies and ensures consumer protection. Japan also amended the Banking Act this year to promote open-innovation between banks and FinTech firms. This amended Act calls on banks to introduce open application program interface (API), while requiring electronic payment service agencies, which is one of the most developed FinTech business models in Japan, to register and manage information appropriately. Meanwhile, the Hong Kong Monetary Authority (HKMA) enacted a new ordinance in November 2015, which provides for a licensing regime for stored value facilities as well as supervisory powers for implementation. The Ordinance also establishes a designation regime for retail payment systems under which the HKMA may designate retail payment systems that meet certain designation criteria and subject them to HKMA's oversight. The European Union (EU) has also revised in 2015 its directive on payment services for regulating new FinTech players, such as payment data aggregators and payment initiation service providers.

To enhance efforts to combat money laundering and terrorism financing, several jurisdictions⁵² have also changed the methods for ascertaining the identity of clients, such as new, more flexible know your customer (KYC) identification rules, use of electronic signatures, and biometric information.

⁵¹ Argentina, Australia, Canada, China, EU (France, Germany, Netherlands, Spain, United Kingdom), Hong Kong, Indonesia, Korea, Japan, Mexico, Pakistan, Singapore, South Africa, Switzerland, and Turkey.

⁵² Canada, EU (France, Germany, Italy, Netherlands, Spain, United Kingdom), Hong Kong, and Russia.

4.1.2 Deposits, lending and capital raising

Many jurisdictions⁵³ have amended or clarified existing rules for equity crowdfunding and for online marketplace lending, which have also been a significant focus of IOSCO. These changes include defining new licensing requirements or clarifying where existing rules continue to apply. In Mexico, a proposed law to be reviewed by the National Congress would mandate the banking and securities regulator to be the regulatory authority of crowdfunding platforms. While many jurisdictions had implemented regulatory regimes for crowdfunding by 2015,⁵⁴ a few jurisdictions have since amended or are considering additional revisions to existing rules. Canada also introduced new crowdfunding rules in May 2015, followed by further amendments in November 2015 and January 2016 that allow companies to use equity crowdfunding to raise capital subject to certain conditions. In Australia, new rules to enable crowd-sourced equity funding will commence from September 2017, and an extension to allow smaller, closely held companies to access crowd-sourced equity is being developed. Meanwhile, the UK is conducting a post-implementation review of the crowdfunding market and regulatory framework. Possible further rule changes could include applying additional controls to more complicated business models and potentially setting investment limits to cap potential consumer harm. In Indonesia, the Financial Services Authority enacted regulation on the legal structure and governance of IT-based direct lending and borrowing services in December 2016 and issued a circular letter in April 2017 for governance and risk management regarding IT-based direct lending and borrowing services.

Meanwhile, China is conducting research to learn from international experience before developing a regulatory framework for equity-based crowdfunding. In the context of online marketplace lending (including online lending platforms), China has been active in issuing a number of rules and guidelines to ensure domestic FinTech credit activity is captured. Canada has also issued expectations for businesses operating or planning to operate online lending platforms, while Brazil plans to issue new regulation for P2P lending.

4.1.3 Insurance

The IAIS took stock of innovations in the insurance sector (InsurTech) and noted that, while growing, investment in technology within the insurance sector is lagging in comparison with the banking sector.⁵⁵ Indeed, only China, India and Russia reported making regulatory changes that aim at improving accessibility of insurance services through electronic sales of certain insurance products. In Russia, further amendments to disclosure requirements are envisaged. Meanwhile, Hong Kong reviewed its regulatory regime to account for FinTech and decided that no changes were needed at this stage.

⁵³ Argentina, Australia, Brazil, Canada, China, EU (France, Germany, Italy, Netherlands, Spain, United Kingdom), Hong Kong, Indonesia, Kenya, Korea, Singapore, and Turkey.

⁵⁴ IOSCO (2015), "[Crowdfunding 2015 Survey Responses Report](#)," December.

⁵⁵ IAIS (2017).

4.1.4 Investment management and investor services

A number of jurisdictions⁵⁶ have issued or plan to issue guidance for robo-advice. Most of these changes clarified existing rules within the securities regulatory framework. That is, the registration, suitability rules and conduct requirements are “technology neutral” – the same rules apply whether a portfolio manager operates under the traditional model or an online platform.

4.1.5 Market support

Cloud computing applications are covered under regulatory regimes for managing third parties, as set out in the regulatory and supervisory frameworks for banks. France, Singapore, South Africa and the UK reported that they have revised or issued new guidance on prudent risk management practices for the outsourcing of functions to address the use of cloud computing in particular.

4.2 Challenges to monitoring FinTech activities

While the majority of authorities have reviewed their existing regulatory frameworks and some have made amendments to account for FinTech activities, a number of FinTech activities and business models may not be captured within their regulatory frameworks. As an example, authorisation requirements for banks generally aim at banking activities (deposit-taking, lending business) with the corresponding risk exposure and regulation. Some FinTech firms may consider certain banking licences a considerable cost for them when their business model may have more limited activities. To the extent that FinTech firms structure their activities in fundamentally the same fashion as banks, FinTech credit platforms could be considered to be benefiting from regulatory arbitrage.

Regulatory perimeter issues may also affect the ability for authorities to monitor FinTech developments, depending on the flexibility provided already by the existing regulatory framework. In this light, the Legal Entity Identifier (LEI) may be a way to support data collection and reporting on Fintech, in a way that facilitates cross-border cooperation and information exchange.⁵⁷ While the abundance of data is itself at the heart of many FinTech developments, some regulators note having few official data sources and poor data quality to monitor the sector well, in part because entities fall outside the regulatory perimeter or are not (fully) subject to reporting requirements. Many authorities use private sector, academic or consultant estimations for monitoring and policymaking. Some entities may even fall under the regulatory perimeter but have few or no financial reporting obligations due to, for instance, their small size or because they are registered under licences that involve fewer reporting requirements than full banking licences. In addition, existing technology and e-commerce companies may leverage customer data to move into financial services, blurring the boundaries of the financial and non-

⁵⁶ Australia, Brazil, Canada, China, EU (France, Germany, Italy, Netherlands, Spain, United Kingdom), Hong Kong, Korea and the United States.

⁵⁷ The LEI is a 20-character reference code promoted by the FSB and G20 to uniquely identify legally distinct entities that engage in financial transactions and support more reliable management of data on legal entities. LEIs are issued and managed by a network of independent operators federated by the Global LEI Foundation (GLEIF) under the oversight of the LEI Regulatory Oversight Committee (LEI ROC). The LEI ROC gathers over 90 official sector bodies from more than 50 countries. See: www.leiroc.org and www.gleif.org.

financial corporate sectors.⁵⁸ These technological applications and business models may not be included in traditional reporting requirements. Thus, licensed FinTech businesses' information may not be directly identifiable within traditional statistics available on banks, asset managers and insurers, which underscores the need for regulatory and supervisory approaches to FinTech be more activities-based rather than entity-based.⁵⁹ The challenge, however, is that the "entity" is the point of entry for most authorities.

In some cases, some regulators believe that sandboxes, accelerators and innovation hubs, as well as other forms of interaction⁶⁰, could be an important source of information about new FinTech activities and their business models, which are important to understand risks and incentives. Many authorities have implemented innovation facilitators, such as "regulatory sandboxes" (e.g. Australia, Hong Kong, Korea, Malaysia, Singapore, Thailand, UK)⁶¹, "innovation hubs" (e.g. Australia, France, Hong Kong, Japan, Korea, UK) and "innovation accelerators" (e.g. Singapore, UK), or other forms of interaction such as workshops, conferences and regular dialogue with market participants. In many cases, there are multiple facilitators in the same jurisdiction. Broadly, regulatory sandboxes can be defined as frameworks for testing new technologies in a controlled environment. Innovation hubs entail support of new firms in navigating existing regulatory requirements. Accelerators are dedicated means of cooperation, which may include funding support. As these facilitators are just being implemented, the experience in providing benefits for firms and regulatory expertise that will develop as a result should be evaluated through time and will be an area for international discussion and peer learning.

Authorities, however, are generally focused on how FinTech is affecting the domestic financial landscape; cross-border issues are generally not being discussed. In several jurisdictions, frameworks address domestic market participants. Brazil and Singapore mention the use of FinTech for remittances, where issues pertaining to cross-border payments, such as licensing of foreign-based service providers, would require further discussion. In some cases, regional cooperation is a relevant factor. For example, in the EU, participants are often considered on an equal footing; a similar framework applies for the East African region (of which Kenya is a part). Canada and Turkey mention the need to deal with AML/CFT issues or illegal transactions of an international nature, while Indonesia has tailored rules to encourage the inflow of foreign

⁵⁸ Dirk Zetsche, Ross Buckley, Douglas Arner, and Janos Nathan Barberis (2017), "From FinTech to TechFin: The Regulatory Challenges of Data-Driven Finance," European Banking Institute Working Paper No. 6.

⁵⁹ This is the case in Europe, whose regulatory framework is more activity, as opposed to entity, based relative to other jurisdictions.

⁶⁰ For instance, in France, the prudential authority in charge of banking and insurance supervision (ACPR) and the securities markets regulator (AMF) created jointly in July 2016 the so-called "Forum FinTech," gathering up to 36 members coming from the FinTech sectors as well as more traditional banking and insurance sectors and involving also public authorities (such as the Ministry of Finance but also regulatory authorities in charge of data privacy, information security and fight against money laundering and terrorism financing). It is meant to share learnings between professionals, experts and Public Authorities about the issues, concerns, specificities and risks related to the FinTechs.

⁶¹ Mexico is considering this model in the Draft Law. In the EU, members chose to follow a so-called "proportionate approach" in the field of payment services (see the Payment Service Directive 1 and 2) according to which live-testing of new technologies in a controlled environment is possible before applying for a full payment institution licence without jeopardising the "technological neutrality" principle promoted by the EU.

capital, which are subject to the AML/CFT principles.⁶² Given the virtual footprint of many innovations, cross-border issues are likely to grow in importance as FinTech develops, and steps have been taken by some authorities to establish more structured cross-border collaboration arrangements such as memoranda of understanding and co-operation agreements (e.g. Australia, France, Indonesia, Singapore and the UK).

There is much work underway on enhancing cyber-security, but these efforts are not necessarily shared publicly, largely for national security purposes.⁶³ While cyber risk is not unique to FinTech, greater connectivity from digital solutions expands the number of entry points for cyber hackers in search of a weak link in the network. This may be particularly relevant for client-facing applications using customer data, and new devices, including those connected to the “Internet of Things.” Indeed, a number of recent incidents have involved fraud and theft through mobile banking apps, and there have been breaches of personally identifiable information, particularly as a large number of mobile devices lack anti-virus software.⁶⁴ This raises issues of financial risk, data privacy, data ownership and administration, and legal liability. The capital regime for operational risk is far less advanced compared to the regime for market risk and credit risk for some types of financial institutions. More importantly, while measures such as capital requirements can create incentives to address certain operational risks, such as business continuity, capital is not sufficient to restore operations if a financial institution suffers a cyber incident. Consequently, the growth of some FinTech activities may further underscore the importance of prevention and detection of these operational risks as a complement for appropriate capital.

5. FinTech issues that merit authorities’ attention

FinTech innovations can bring many opportunities. Innovations may already broaden access to finance for individuals and small businesses. New applications may enhance business processes, such as payments and settlements, compliance and risk management. At the same time, FinTech may lead to a number of practical issues from a financial stability point of view that regulatory and supervisory authorities should consider in order to support the development of a strong and sustainable financial system as innovations in financial services mature and are more broadly adopted.

Drawing on the findings of the literature, discussions with academics and industry participants, and a stocktake of regulatory approaches to FinTech, the FSB has identified 10 issues that merit authorities’ attention, of which three are considered priorities for international cooperation. Many of these issues are not new but may be accentuated given the speed of growth of FinTech, new forms of interconnectedness, and increased dependencies on third-party service providers.

⁶² Recently, the Financial Action Task Force (FATF) has released guiding principles (the “San Jose Principles”) on how the public and private sectors can cooperate to support innovation and manage AML/CFT risks. See FATF (2017), “[Chairman's Summary of the FATF FinTech and RegTech Forum 2017, San Jose, California, United States](#),” May.

⁶³ Publicly released guidance on cyber-security include CPMI and IOSCO “(2016), “[Guidance on cyber resilience for financial market infrastructures](#),” June; the G7 (2016), “[Fundamental Elements of Cybersecurity for the Financial Sector](#),” October; and the National Institute of Standards and Technology (NIST) (2017), “[Framework for Improving Critical Infrastructure Cybersecurity](#),” January.

⁶⁴ FireEye (2017), “M-TRENDS: A View From the Front Lines 2017,” March.

There are clear benefits to greater international cooperation given the commonalities and global dimension of many FinTech activities. Cooperation may also reduce the scope for regulatory arbitrage. In this context, there is potential for international bodies, like the FSB, the GPFI and SSBs – such as the BCBS, IAIS, IOSCO and CPMI – to provide avenues for authorities to get together to share experiences and consider implications for financial markets. Increased cooperation will be particularly important to mitigate the risk of fragmentation or divergence in regulatory frameworks, which could impede the development and diffusion of beneficial innovations in financial services, and limit the effectiveness of efforts to promote financial stability. Addressing these priority areas are seen as essential to supporting authorities' efforts to safeguarding financial stability while fostering more inclusive and sustainable finance.

1. ***Managing operational risks from third-party service providers.*** Third-party service providers to financial institutions are quickly becoming more prominent and critical, especially in the areas of cloud computing and data services. The fact that many third-party providers may fall outside the regulatory perimeter places increased emphasis on the importance of managing related operational risks, which could ultimately undermine financial stability. In this regard, authorities should determine if current oversight frameworks for important third-party service providers to financial institutions are appropriate, e.g. in cloud computing and data services, in particular if financial institutions are relying on the same third-party service providers. This may entail greater coordination globally across financial authorities, and with non-traditional partners such as authorities responsible for IT safety and security.
2. ***Mitigating cyber risks.*** Recent reports of significant and successful cyber-attacks underscore the difficulties of mitigating cyber risk. While replacing legacy systems may serve to reduce cyber risk in some areas, it could be heightened in other areas due to an increased number of points of access to core parts of the financial system. Further, the competitive advantage resulting from quick time-to-market may cause a premature adoption of new technologies that have not undergone sufficient testing or do not yet possess the necessary safeguards. Cooperation at the global level has the potential to minimise undesirable consequences of fragmentation of the cyber-security efforts and raise awareness of cyber risks. Ex ante contingency plans for cyber-attacks, information sharing, monitoring, a focus on incorporating cyber-security in the early design of systems, and financial and technology literacy could help to lower the probability of cyber events that have adverse effects on financial stability. Incorporating cyber-security in the design of systems early on and financial and technology literacy are also important in developing a culture of risk awareness among users, with the potential for such education to lower the probability of cyber events that have adverse effects on financial stability.
3. ***Monitoring macrofinancial risks.*** While there are currently no compelling signs of these risks materialising, experience shows that they can emerge quickly if left unchecked. Systemic importance and procyclicality could emerge from a number of sources, including from greater concentration in some market segments and if funding flows on FinTech lending platforms were to become large and unstable. However, any assessment of the implications of FinTech for financial stability is challenged by the limited availability of both official and privately disclosed data in the FinTech area. There also might be opportunities to improve the quality of information available to regulators, supervisors and overseers, to drive improved efficiency and effectiveness in regulatory

compliance. Short-term benefits would include reduced compliance costs, while long-term benefits could include deriving greater value from regulatory data by unlocking new insights, including through RegTech. In order to harness these benefits, authorities should consider developing their own capacity to access and assess existing and new sources of information that could be made available through various means, including FinTech, which could help limit the regulatory reporting burden for firms.

5.1 Other issues that may merit authorities' attention

Because innovations in financial services are developing fast, authorities may further wish to consider the following issues:

4. ***Cross-border legal considerations and regulatory arrangements.*** Cross-border cooperation and coordination among authorities are important to a well-functioning financial system. Innovations in cross-border lending, trading and payment transactions, including via smart contracts, raise questions about the cross-jurisdictional compatibility of national legal frameworks. The legal validity and enforceability of smart contracts and other applications of DLT are in some cases uncertain, and should be discussed further. In addition, in some cases, certain technological structures around DLT and smart contracts may not necessarily be designed to comply with the laws of all potential jurisdictions, thus affecting the unimpeded use on a cross-border basis.
5. ***Governance and disclosure frameworks supporting big data analytics.*** Applications of big data are becoming more prevalent as a basis for financial services across the full range of economic functions, including lending, investment and insurance. Big data analytics are driving transformation across industries with the ability to conduct extensive analytics rapidly and enhance risk identification and assessment. Similar to the use of algorithms in other domains, such as securities trading, the complexity and opacity of some big data analytics models makes it difficult for authorities to assess the robustness of the models or new unforeseen risks in market behaviour, and to determine whether market participants are fully in control over their systems. Many algorithms are inherently difficult to interpret and may not be subject to the same governance and auditability as banking and insurance models. More time is needed to fully assess the benefits and desirability of non-traditional data sources and AI-based algorithms to measure and price risk. To the extent that trust in the system supports financial stability, consumer protection issues, such as data privacy, could also be relevant.
6. ***Assessing the regulatory perimeter and updating it on a timely basis.*** Regulators should be agile when there is a need to respond to fast changes in the FinTech space, and to implement or contribute to a process to review the regulatory perimeter regularly. This may be more easily and efficiently achieved with an approach that is neutral with regard to technologies and based on financial services activities.
7. ***Shared learning with a diverse set of private sector parties.*** In order to support the benefits of innovation through shared learning and through greater access to information on developments, authorities should continue to improve communication channels with the private sector and to share their experiences with regulatory sandboxes, accelerators and innovation hubs, as well as other forms of interaction. Successes and challenges

derived from such approaches may provide fruitful insights into new emerging regulatory engagement models.

8. ***Further developing open lines of communication across relevant authorities.*** Due to the potentially growing importance of FinTech activities and the interconnections across the financial system, authorities may wish to develop further their lines of communication to ensure preparedness.
9. ***Building staff capacity in new areas of required expertise.*** Supervisors and regulators should consider placing greater emphasis on ensuring they have the adequate resources and skill-sets to deal with FinTech.
10. ***Studying alternative configurations of digital currencies.*** The implications of alternative configurations of digital currencies for national financial systems, and the global monetary framework should be studied.⁶⁵ Digital currencies and alternative payment arrangements based on new technology are developing at different speeds across jurisdictions, along with a decline in the use of cash for transactions in some jurisdictions. At the same time, work is underway to increase the efficiency, and to lower the costs, of cross-border transactions at both the wholesale and retail levels. In addition to monitoring developments, relevant authorities should analyse the potential implications of digital currencies for monetary policy, financial stability and the global monetary system. One issue is the use of some virtual currencies for illegal activities (including cyber-attacks).

5.2 Ongoing monitoring of FinTech

The FSB will continue to monitor and discuss the evolution of the potential financial stability implications from FinTech going forward, using its existing Financial Innovation Network. While there are currently no compelling signs of macrofinancial risks materialising, experience shows that they can emerge quickly if left unchecked. The importance and prevalence of complex networks and associated contagion effects could increase as FinTech gains prominence; indeed this may be an outcome of cloud computing services and DLT. Systemic importance may surface, including interconnectedness and centrality issues. Procyclicality could emerge from a number of sources, including from greater concentration in some market segments and if funding flows on FinTech lending platforms (which may not currently be in scope for macroprudential tools) were to become large and unstable.

It is also crucial at this stage to gain a deeper understanding of business models of both emerging FinTech companies and incumbents in the financial sector as they evolve, with an eye on the underlying financial drivers and possible frictions. Future changes to market structure, such as the level of competition, contestability and market composition could all influence various business models in the system, possibly affecting financial stability in ways that cannot be predicted at this stage.

⁶⁵ Dong He, Ross Leckow, Vikram Haksar, Tommaso Mancini-Griffoli, Nigel Jenkinson, Mikari Kashima, Tanai Khiaonarong, Céline Rochon and Hervé Tourpe (2017), "[Fintech and Financial Services: Initial Considerations](#)," IMF Staff Discussion Note, SDN/17/05, June.

Glossary

Given the relatively recent nature of many innovations, it is important to be precise on their definitions. This glossary provides a (non-exhaustive) list of technologies and terms used in the FinTech space and throughout the report.

- **Artificial intelligence:** IT systems that perform functions requiring intelligence when performed by people.
- **Big data:** A generic term that designates the massive volume of data that is generated by the increasing use of digital tools and information systems.
- **Cloud computing:** An innovation in computing that allows for the use of an online network (“cloud”) of hosting processors so as to increase the scale and flexibility of computing capacity. Cloud computing has made possible the analysis of very large datasets (big data), and a number of specific FinTech applications.
- **Crowdfunding:** Equity and loan crowdfunding is the practice of funding a project or venture by raising monetary contributions from a large number of people. It is often performed today via internet-mediated registries that facilitate the money collection for the borrower (lending) or issuer (equity). See also online FinTech lending.
- **Digital currencies:** These include private currencies, such as Bitcoin, Ethereum, Ripple and Litecoin, and digital versions of national bank currencies. Because of the use of cryptography techniques, a (large) subset of digital currencies are referred to as “cryptocurrencies.”
- **Digital ID verification:** A range of technologies used to confirm the identity of actors in financial transactions or other applications, e.g. to prevent fraud and to ensure the security of clients and counterparties.
- **Distributed ledger technology (DLT):** A means of saving information through a distributed ledger, i.e. a repeated digital copy of data at multiple locations, as in a blockchain. Current experiments with DLT applications in securities settlement aim for speeding up settlement and reducing back-office costs while providing greater transparency of transactions and holdings.
- **e-Aggregators:** Also known as price comparison websites or comparison aggregators, provide internet-based venues for retail customers to compare the prices and features of a range of financial products such as standardised insurance, mortgages, and deposit account products. e-Aggregators also provide an easy way to switch between providers.
- **e-Trading:** A broad category of financial market trading methods on electronic trading platforms and virtual market places. This can include algorithmic or high-frequency trading among professional investors, and online investment, “social trading” or “copy trading” among retail investors (see below).
- **FinTech:** Technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on the provision of financial services.
- **FinTech credit:** Credit activity facilitated by electronic platforms whereby borrowers are matched directly with lenders. These entities are commonly referred to as “loan-based

crowdfunders”, “peer-to-peer (P2P) lenders” or “marketplace lenders”.⁶⁶ Such electronic platforms can facilitate a range of credit obligations, including secured and unsecured lending, and non-loan debt funding such as invoice financing.

- **Innovation facilitator:** Public sector initiatives to engage with the FinTech sector, such as regulatory sandboxes, innovation hubs and innovation accelerators.
- **Internet of Things:** Software, sensors and network connectivity embedded in physical devices, buildings, and other items that enable those objects to: (i) collect and exchange data and (ii) send, receive and execute commands.
- **Mobile and web-based payments:** Applications that allow consumers to conduct transactions through their mobile phone or tablets, improving efficiency and the customer experience.
- **RegTech:** Any range of applications of FinTech for regulatory and compliance requirements and reporting by regulated financial institutions. This can also refer to firms that offer such applications. There is also a close link with “SupTech,” or the use of FinTech by supervisory authorities.
- **Robo-advisors:** Applications that combine digital interfaces and algorithms, and can also include machine learning, in order to provide services ranging from automated financial recommendations to contract brokering to portfolio management to their clients. Such advisors may be standalone firms and platforms, or can be in-house applications of incumbent financial institutions.
- **Smart contracts:** Programmable distributed applications that can trigger financial flows or changes of ownership if specific events occur.
- **Social trading:** A range of trading platforms that allow users to compare trading strategies or copy the trading strategy of other investors. The latter is often referred to as “copy trading” or “mirror investing.”
- **Tokens:** Any digital representation of value. There is often a close relationship with digital identification verification for information security purposes.

⁶⁶ These terms are used in different contexts: loosely to describe all FinTech lending activity, or more narrowly to describe certain aspects of FinTech lending. “P2P lending” and “loan-based crowdfunding” are used in this report synonymously, as the main category of FinTech credit. “Marketplace lending” is a broader term, which includes lending financed to a greater extent from wholesale sources. FinTech credit is the broadest category, which includes both marketplace lending and non-loan obligations such as invoice trading.

Annex A – Common drivers of FinTech innovations

There are three common and inter-related drivers of FinTech innovations:⁶⁷ (i) shifting customer expectations and other demand factors, (ii) evolving technology, and (iii) changes in financial regulation and market structure.

Shifting consumer expectations

While a firm can offer an innovation to the market, it will not be successful unless there is demand for the innovation. A number of unique demand factors are driving the adoption of FinTech innovations. The ubiquity of internet access and the real-time transacting capability of users of internet-connected devices have given rise to higher customer expectations with regard to convenience, speed, cost and user-friendliness of financial services, which has in turn become one of the most important factors in consumer purchasing decisions. With an estimated two billion global customers without basic banking accounts and services, financial inclusion is also an important issue in many jurisdictions.⁶⁸ FinTech in many cases attempts to fill the gap by providing easy to understand and convenient services, which tend to lower costs of adoption and lower barriers to access for customers.

Relatedly, there are demographic factors driving demand. These include the growing financial influence of computer- and mobile-savvy millennials, and economic development and convergence factors that tend to ease the adoption of FinTech in some rapidly growing emerging market and frontier economies. Both of these factors have potential to significantly increase the user base of FinTech. Finally, many FinTech innovations may display positive network externalities that influence demand. For example, the more users there are of a digital currency or a crowdfunding platform, the more readily they can be used for transactions and hence the more benefit to each user.

Rapidly evolving technologies

Innovations in financial services are applying rapidly evolving technologies in new ways and leveraging different business models. New technologies include big data, artificial intelligence, machine learning, cloud computing and biometrics. Other innovations are seeking to apply new technologies such as DLT. The fact that many incumbents in the financial sector are operating with legacy systems has in many cases increased the marginal value of these new business models and applications of technology in a manner that has reduced barriers to entry and further enabled new players in the financial services sector. Some argue that, just as the internet democratised data and information, these technologies have the potential to democratise finance.⁶⁹ At a minimum, the combination of some technologies together with access devices in the palms of consumers such as cell phones and other mobile devices connected to the internet has added a new dimension to the digital world.

Greater connectivity allows new forms of service provision. Advances in financial services include new mobile payment services (such as PayPal (US, Europe), Alipay (China), new

⁶⁷ de Haan, et al (2015).

⁶⁸ GPF (2017), "[German 2017 Priorities Paper](#)," January.

⁶⁹ The Economist, "[The FinTech revolution](#)," 9 May.

FinTech lending platforms (e.g. Lending Club (US) and Zopa (UK), Lufax (China)) and even low cost investment products. Such services-at-your-fingertips could augur well for increased choice and access to services, especially in some emerging markets. The very notion of currency has been challenged with internet or digital currencies such as Bitcoin and Litecoin being offered as non-fiat currencies. Like the internet enabled data-over-internet protocol (IP) and voice-over-IP, the internet and combinations of technologies such as cryptography has enabled value-over-IP.

A number of factors could make these innovations different from past financial services developments:

- ***Tight integration of different technologies*** – technologies are being combined to produce familiar offerings such as payment or lending services in new ways (process innovation), leading to new business models.
- ***Nimbleness and flexibility of new players*** – unlike in the past with telephone banking or internet banking driven by incumbents, new players, who are not constrained by legacy systems or processes, have the capacity to move through the system development life cycle in a fast and agile manner.
- ***Scope of innovation*** – this has led predominantly to innovative new solutions across the entire financial services landscape including payments, remittances, lending and investments. Although payments and lending has seen the bulk of innovations – perhaps related to the risk and know-how aspects described by Dermine (2016)⁷⁰ – sentiment remains that no financial services domain will be spared over time.
- ***Rate of adoption*** – when information can be available on demand and available on mobile devices through simple message structures or sophisticated “apps”, consumers can be made aware of new service offerings as quickly as the offerings are made available to the market. The rate of adoption of services may therefore happen more quickly than in the past.

Changing financial regulation and market structure

Since the global financial crisis of 2008/9, policymakers and regulators pursued actions intended to reduce the risk of future crises. Prominent actions include: the review of balance sheet requirements, such as higher capital and lower leverage requirements in the banking sector; addressing the risks posed by shadow banking entities and activities; the evaluation of the robustness of resolution and recovery regimes, including additional stress testing requirements; the regularisation of the over-the-counter derivative markets; and the review and enhanced requirements for FMIs (such as payment systems, securities and derivatives market infrastructures). These combined changes in financial regulation may have resulted in many intended shifts in financial activity and related pricing. As a result of this and potentially other factors, such as a low interest rate environment that increase desire for cost cutting and more efficient use of capital, traditional financial firms, including banks, have reduced or withdrawn from some activities. For example, higher capital requirements may have resulted in the change

⁷⁰ Jean Dermine (2016), “[Digital banking and market disruption – a sense of déjà vu](#),” Banque de France, Financial Stability Review, No 20.

in some banks' lending behaviour. Some attribute the ability of online marketplace lenders to get a toehold in credit provision to banks' scaling back of some riskier lending. Moreover, there is the possibility that new regulations have created incentives to develop new services and business models that rely on regulatory arbitrage.

Concurrently, the global financial crisis has impacted incumbent financial institutions through several channels. Shocks to wholesale funding and repo markets have compelled banks to build sounder funding structures, based for instance on stable deposits. This, combined with greater investor risk aversion, may have also forced deleveraging by some banks. Finally, the sale of foreign activities and the (voluntary or policy-induced) restructuring of global banks may have entailed a retreat from some business lines and market segments.

Regardless of the origin of such shifts in the global financial system, these developments have opened the door to new entrants. These players may be able to use technology to scale up faster and in more cost effective manners than established institutions. This in turn has led incumbents to imitate and acquire emerging FinTech solutions, and spurred the incumbents to develop their own technology in these areas.

Annex B – Case study on retail payments and digital wallets

Description

Digital wallets provide a method of making payments electronically. Specifically, they allow users to make transfers between transaction accounts. Transaction accounts can be either traditional bank accounts or pre-funded “e-money” accounts at non-bank payment service providers (often the digital wallet provider itself). Transfers can be for a range of purposes, including bilateral payments between consumers, and payments from customers to businesses in exchange for goods and services. Examples of digital wallets include:

- **PayPal** – PayPal allows customers to pay for goods at online checkouts, by triggering card payments or direct transfers from linked bank accounts. PayPal also offers pre-funded transaction accounts, which customers can use to pay.
- **Apple, Android and Samsung Pay** – These allow customers to use their phone to trigger contactless payments from linked credit or debit cards to merchants at physical and online checkouts.
- **Alipay** – Alipay is China’s leading service provider to online retailers and digital wallet. Customers can pay for goods on Alipay using pre-paid balances or a linked bank account.
- **M-Pesa** – M-Pesa is a mobile-based digital wallet, which allows users to exchange pre-loaded phone credit balances that effectively act as e-money. M-Pesa began in Kenya and has since been adopted in a number of other countries in Africa and elsewhere.

Digital wallets can reduce transaction costs in the financial system, including for instance, costs related to the speed and convenience of transacting. Where no electronic payment method is currently available, digital wallets allow goods and services to be traded online, or in physical locations. Where card payments are already possible, digital wallets may increase efficiency by allowing merchants or customers to rely on a simple (secure) login to make a payment, rather than providing full card details online.

Statistics on digital wallets could help to quantify risks. Yet data on transaction volumes through digital wallets and balances held in e-money accounts are currently sparse.

Potential to support financial stability

Digital wallets could enhance operational resilience in the payments system. Payment services have to-date often been dominated by banks, in a generally concentrated system. If the number of ways for consumers to make payments further increases, the impact on real economy transactions of any single payment service provider suffering an outage should further reduce. This reduction would, however, be limited by the reliance of digital wallet providers on existing payments infrastructure and any agency banks used to access the payment system.

Digital wallets could increase access to, and efficiency in, financial services. By increasing the provision of affordable transaction accounts, and introducing new and convenient digital payment services in economies where these are currently limited, digital wallets could open up access to financial services and support real economic activity. Separately, as described by the CPMI, digital wallets could contribute to the G20’s Financial Inclusion Action Plan and the World Bank’s Universal Financial Access initiative. In Kenya, for example, the proportion of

adults with access to formal financial services has grown from 40% in 2009 to 75% in 2016, partly owing to the growth of mobile money services such as M-Pesa.⁷¹

Potential to undermine financial stability

Digital wallets could expose the payments system to greater risk of cyber-attack. If the number of entry points to the payment system increases, the number of potential targets for cyber-attacks will increase. If some of these new providers have lower security standards than current incumbents – due to less stringent regulation or otherwise – there is also a greater chance that these attacks will be successful. A successful attack could directly impact the provision of payments services to the real economy. Even where new entrants have superior encryption standards, increasingly digitised access to customer funds may increase the returns to cyber-attack and the impact on end consumers.

Digital wallets providing transaction accounts could be exposed to financial risks, including through engaging in shadow banking. Digital wallets could invest customer balances in risky assets, taking on bank-like risks, such as liquidity mismatch, without the attendant prudential regulation. This might be more likely if the wallet provider is intentionally engaging in regulatory arbitrage. In the EU, e-money providers are prohibited from investing client funds under the E-Money Directive, which requires them to place customer balances in bank deposits or secure, low-risk assets such as government bonds. In the US, PayPal has in the past invested client funds in its own money market fund. In China, Alipay allows customers to transfer balances instantly in-app to its Yu’e Bao fund, now the third largest money market fund in the world with assets under management of \$115 billion. Digital wallet providers may also face financial risk from the running of their business, particularly where they have other business lines as well. This could also increase the likelihood of customer losses if funds are not appropriately segregated. Were a digital wallet provider to fail following a financial stress, this could disrupt the provision of critical services to the economy. The behaviour of a major provider during a stress could also disrupt the functioning of systemically important markets, if for example it had to liquidate assets quickly.

Digital wallets could become a focal point for reputational contagion. Distress experienced by a digital wallet, including through misconduct issues, could undermine confidence in the sector as a whole. This could be particularly concerning if digital wallets came to replace traditional bank-based payment services.

Digital wallet providers could become systemically important. Despite prospects for increased competition, a small number of providers could in practice come to dominate the market. For example, Apple Pay accounts for over 75% of contactless payments in the US. Providers are likely to dominate the market due to network effects, or if they are able to provide transaction services at lower cost (for example, through cross-subsidies or regulatory arbitrage). Such dominance could increase concentration and operational risk at the front-end of the payments system, increasing risks to the provision of critical services.

⁷¹ Central Bank of Kenya, Kenya National Bureau of Statistics and Financial Sector Deepening Kenya (2016), [The 2016 FinAccess Household Survey on financial inclusion](#), February.

Annex C – Case study on FinTech credit

Description

FinTech credit refers to credit activity facilitated by electronic platforms. This usually involves borrowers being matched directly with investors, although some platforms use their own balance sheet to lend. These entities are commonly referred to as “loan-based crowdfunders,” “P2P lenders” or “marketplace lenders.”⁷² Such electronic platforms can facilitate various forms of credit, including secured and unsecured lending, and non-loan debt funding such as invoice financing. Aside from the ‘traditional’ P2P lending platform model, business models include the notary, guaranteed return, balance sheet and invoice trading.

Academic survey data on lending volumes show considerable dispersion in FinTech credit market size across jurisdictions. In absolute terms the largest FinTech credit market is China, followed at a distance by the US and the UK. In general, FinTech credit represents a small fraction of overall credit, but it is growing very rapidly and may have larger shares in specific credit market segments.⁷³ Greater decentralisation and increased intermediation by these new credit providers are likely to deliver a mix of both positive and negative implications for financial stability.

This case study draws from the CGFS-FSB report on FinTech Credit. The report discusses the market structure, business models and financial stability implications of FinTech credit.⁷⁴

Potential to support financial stability

FinTech credit can increase competition in lending. By leveraging new technologies, FinTech lending platforms should in theory be able to offer more competitive borrowing rates. In practice, there is mixed evidence on interest rates as compared to traditional banks.⁷⁵ In addition, by increasing contestability of the lending market, these platforms are able to compete with traditional lenders and increase the overall degree of competition in credit markets. FinTech platforms may also pressure incumbent banks to be more efficient in their credit provision.

New platforms can drive financial inclusion. While this is a policy goal in its own right, a greater reach of financial services may also benefit the financial system through various economic channels. For example, with greater inclusion, investors may have access to alternative products that are less correlated with other asset classes. In addition, borrowers with

⁷² These terms are used in different contexts: loosely to describe all FinTech lending activity, or more narrowly to describe certain aspects of FinTech lending. They are used here as categories of FinTech credit.

⁷³ The CCAF estimates the volume of new FinTech credit in 2015 at \$99.7 billion in China, \$34.3 billion in the US and \$4.1 billion in the UK. FinTech credit is around 0.6% of overall credit in China, and 1.4% of the outstanding stock of bank credit to consumers and small and medium enterprises in the UK at end-2016. At the same time, FinTech credit accounted for nearly 14% of equivalent gross bank lending flows to UK small businesses in 2015. See CCAF and Nesta (2016), “Pushing boundaries: the 2015 UK Alternative Finance Industry Report,” February.

⁷⁴ CGFS-FSB (2017).

⁷⁵ For the US, see Y. Demyanyk and D. Kolliner (2014), “Peer-to-Peer Lending Is Poised to Grow,” Federal Reserve Bank of Cleveland. August; and G. Buchak, G. Matvos, T. Piskorski and A. Seru (2017), “FinTech, Regulatory Arbitrage, and the Rise of Shadow Banks,” NBER Working Paper No. 23288, March. For Germany, see C. de Roure, L. Pelizzon, and P. Tasca (2016), “How Does P2P Lending Fit Into the Consumer Credit Market?” Deutsche Bundesbank Discussion Paper No. 30/2016. Demyanyk and Kolliner find lower rates, Buchak et al. find higher rates when controlling for borrower risk characteristics, and the latter studies find no significant differences when controlling for borrower risk characteristics.

limited access to bank-intermediated credit (such as small businesses and self-employed individuals) may be able to obtain the funding they need for investment or working capital purposes. The issue of credit availability appears to be especially relevant in emerging market and developing economies, where demand for FinTech credit appears to be relatively strong.

If FinTech credit were to take on greater market share, this could benefit market structure in a few key respects. FinTech credit platforms may help to diversify sources of credit in the economy. A lower concentration of credit in the banking sector might be beneficial in the event that there were problems idiosyncratic to banks. While it is plausible that the funding environment could be unfavourable for FinTech credit platforms if there were concerns over the regulated banking system, FinTech credit platforms might still provide another avenue by which credit could flow to other parts of the economy if bank lending were impaired. Thus, the rapid development of P2P lending could play a useful complement to the role of traditional finance. It is interesting to note, however, that in certain countries, such as the US, banks are becoming a major supplier of funds to FinTech credit platforms thereby offsetting some of the potential benefits of the decentralisation of credit provision.

Finally, interconnectedness in the financial system could be lessened. In general, FinTech lending platforms are unlikely to have significant direct financial exposures to each other as do banks. Unless platforms are funded in large part by the banking sector, this could lead to a more resilient network and positively contribute to the diversification of risk across the financial system. In contrast to traditional banking where lending is funded by on-demand deposits and shorter-maturity funding, FinTech credit platforms have lower maturity mismatch, particularly in the ‘traditional’ P2P model. As such, FinTech lending platforms could enhance the resilience of credit provision in the economy to liquidity shocks, provided that investors understand that platforms are not providers of liquidity and that end investors are not (solely) traditional banks.

Potential to undermine financial stability

The growth of FinTech credit could lead to a reduction in lending standards and more procyclical credit provision. The overall credit risk of FinTech credit is arguably higher than for banks because of untested credit risk models, reliance on investor confidence and no capital backing the activity. There is potential for procyclicality due to, for example, changing risk appetite by retail investors in upturns and downturns. In addition to weaker lending standards in the upswing, there is the risk of a significant cutback of lending by FinTech lenders due to their reliance on investor confidence.

Operational risks may have real economic consequences. If platforms were to grow large enough whereby certain segments of the real economy rely on credit from those platforms, then operational risks in FinTech credit platforms could cause a pullback in credit. FinTech credit platforms may be more vulnerable to some operational risks, such as cyber risk, due to their reliance on relatively new digital processes. The extent of such risks to platforms likely depends on the degree of sophistication of platforms, mechanisms used for the storage of client information and the robustness of their cybersecurity programs.

Regulators may – depending on the jurisdiction – be less able to monitor activity that is more dispersed and outside the regulatory perimeter. As traditional reporting requirements are usually linked to the balance sheet, this makes it difficult to track funds intermediated by platforms even if the latter were inside the regulatory perimeter. A related point is that more

lending activity outside the prudential net may limit the effectiveness of credit-related macroprudential policy measures. Further, platforms at this point have no access to public safety nets, such as central bank emergency liquidity.

The growth of FinTech credit may impact incumbent financial institutions. The increased competition from FinTech lenders could lead to some erosion of profitability. Specifically, the “unbundling” of bank business lines could eat away at revenue bases, making banks more vulnerable to losses and removing access to retained earnings as a source of internal capital. If this happens quickly, this could be a problem given the systemic importance of banks and their provision of critical services. Secondly, banks may be encouraged to increase risk-taking to compete with new platforms by under-pricing risk and weakening lending standards. Third, just as platforms that rely on new (and relatively untested) technologies may be vulnerable to cyber risk, banks may expose themselves to more cyber risk in acquiring or partnering with platforms. Finally, banks using FinTech credit models could be at greater operational or reputational risk due to greater reliance on external technological service providers. For example, a disruption in cloud computing services could disrupt business activities.

Box A: China’s regulatory framework for internet finance

In July 2015, the People’s Bank of China and nine other ministries jointly issued the *Guiding Opinions on Promoting the Sound Development of Internet Finance* (Guiding Opinions) to encourage financial innovation, promote the healthy development of internet finance, clarify the regulatory responsibilities and standardise the market order. In August 2016, the China Banking Regulatory Commission (CBRC) and three other ministries jointly issued the *Provisional Rules for the Administration of the Business Activities of Online Lending Information Intermediary Institutions* (Provisional Rules). Both the Guiding Opinions and the Provisional Rules establish a regulatory framework for FinTech credit. The regulatory policies emphasise that FinTech credit platforms are essentially an information intermediary rather than a credit intermediary. Their online lending service is a financial information intermediary business, involving financial intermediation and related risk management.

The Guiding Opinions require that supervision and regulation of FinTech credit should follow the principles of “*legitimate supervision, appropriate supervision, classified supervision, collaborative supervision, and innovative supervision*.” The supervision of P2P lending should reasonably define the business boundaries and access conditions, implement the supervisory responsibilities, clarify the bottom line of risk, protect legitimate operations, and prohibit illegal behaviours.

The Provisional Rules define the boundaries of FinTech credit platforms’ business by prohibiting certain acts, such as: fund raising for themselves directly or indirectly; accepting and collecting lenders’ funds directly or indirectly; guaranteeing principle or interest for the lenders directly or “euphemistically” (i.e. by implication); authorising a third-party to promote the financing projects in any physical places except for electronic channels; splitting the duration of the financing projects; carrying out asset securitisation or assignment of debt; fabricating or exaggerating the authenticity of financing projects to mislead lenders or borrowers; or engaging in equity-based crowdfunding and other businesses. FinTech credit platforms are also required to deposit client funds at a third-party, i.e. a custodian bank, and are encouraged to strengthen disclosures and to improve risk monitoring and management.

The Provisional Rules stipulate the upper limit of borrowed funds. The upper limit of the borrowing balance of an individual (natural person) is no more than RMB 200,000 (~\$30,000) from one FinTech platform and no more than RMB 1 million (~\$150,000) across all platforms. The upper limit of the borrowing balance of a firm (legal person) or other organisation is no more than RMB 1 million and RMB 5 million (~\$750,000), respectively.

Annex D – Case study on robo-advisors

Description

Robo-advisors offer a range of automated services, from financial recommendations to investment or contract brokering to portfolio management. Such advisors may be stand-alone firms and platforms, or in-house applications of incumbent financial institutions. The exact business model may vary according to the regulatory framework and licencing regime, depending on the jurisdiction. Some operators of online platforms offering automated advisory services provide their customers with the opportunity to receive a diversified portfolio proposal based on personal information provided by the latter. The composition of that portfolio, and any changes made to it, are usually based on algorithms derived from portfolio theory models.⁷⁶

A portfolio proposal created by a robo-advisor is based on similar information as traditional investment advice. First, investors are asked to provide their particulars (such as age, profession or monthly income), investment-related data on the desired investment volume and horizon, and information on their personal investment objectives (e.g. expected risk-return preferences). Robo-advisors normally use online questionnaires to obtain this information. Second, the portfolio proposal builds on the logic of the underlying algorithm, which ultimately selects the investment products and proposes how the portfolio might be composed.⁷⁷

The degree of standardisation can vary strongly among providers of robo-advice. This might also impact the fit between the investment proposal and the individual needs of customers. Investment itself is often in exchange-traded funds (ETFs), but a growing number of providers allow broader range of investments.

Data availability and quality seems to be spotty and uneven across markets and depending on the exact business models. The following section therefore relies on market estimations and data as well as results of academic studies. One should however take into consideration that these data might not present a complete overview of the market, that data obtained on robo-advisors and traditional asset managers might not be fully comparable.

Presently robo-advisors have a relatively small market share in terms of global assets under management (AuM) compared to traditional asset managers. While traditional asset managers' total net assets of regulated open-ended funds worldwide amounted to \$37,191 billion in 2015,⁷⁸ global robo-advisors only managed about \$600 billion, with the US being the leading market worldwide with about \$300 billion worth of investment in 2015.⁷⁹

The US robo-advisory market is the most advanced one with several incumbent asset managers having taken up robo-advisory services. According to estimates, these traditional asset managers intermediate \$52 billion AuM in their robo-advisory arms as of September 2016, implying an average compound growth rate (CAGR) in this segment of 179% compared to the

⁷⁶ Jonathan W. Lam (2016), "[Robo-Advisors: A Portfolio Management Perspective](#)," Yale College, April.

⁷⁷ European Banking Authority (EBA), European Insurance and Occupational Pensions Authority (EIOPA), and European Securities and Markets Authority (ESMA) (2015), "[Joint Committee Discussion Paper on automation in financial advice](#)," December, p. 12.

⁷⁸ Investment Company Institute (ICI) (2016), "2016 Investment Company Factbook," April.

⁷⁹ Business Insider (BI) Intelligence (2016), "[The robo-advising report](#)," June.

previous year. In the same period, innovators (pure robo-advisors) in the US market have grown their AuM by 56% up to \$13.2 billion.⁸⁰

In Australia, start-ups as well as incumbents are developing robo-advisors to tap the AUD 2.3 trillion (\$1.7 trillion) superannuation market. The Australian superannuation system draws on compulsory and voluntary contributions and is supported by tax incentives for contributions and earnings, along with tax-free benefits. Employers pay a compulsory contribution (currently 9.5%) to their employee's superannuation fund on top of employees' wages and salaries. Employees can supplement their balances by making voluntary contributions to the superannuation fund that are concessionally taxed. Robo-advice may be targeted at such employee investments.

In Europe, the proliferation of automated advice, brokerage and management still seems at an early stage. Robo-advisors are entering the asset management sector predominantly in UK, Germany and Italy, and the huge growth potential has the EBA, EIOPA and ESMA closely monitoring further market developments. At this stage, however, they see no need for cross-sectoral regulatory or supervisory action.

Depending on the design of forecasting models, estimates on the prospective size of the robo-advisory market vary strongly. According to BI Intelligence, global AuM intermediated by robo-advisors are predicted to rise to \$8,100 billion by 2020, with Asia projected to account for \$2,400 billion. In the US, the AuM intermediated by robo-advisors are expected to rise to \$2,200 billion by 2020.⁸¹ According to a recent Morgan Stanley Study, robo-advice is expected to reach only \$1,000 billion AuM globally by 2020. Building on this estimate, global AuM of robo-advisors are predicted to reach \$6,500 billion by 2025 in a base case. In the best case scenario, in which launches in 2017 have high take-up rates, estimations go up to \$13,000 billion while in the worst case scenario they are expected to reach \$1,000 billion in 2025.⁸²

Potential to support financial stability

Robo-advisors introduce new players into the asset management sector and hence could increase diversification, contingent upon the diversity of models used. The fact that robo-advisors often channel customers' funds into ETFs and that investment advice is largely automated with limited personal interaction means that robo-advisors boast a potential cost advantage over traditional portfolio advisors. Depending on the geographical region, average recurring fees of robo-advisors are roughly up to 50% of traditional advisor fees, as they generally comprise ETF manufacturing fees and fees of the robo-advisors, whereas traditional providers include fees for personal advisory, distribution (platform) and the manufacturing of ETFs or mutual funds.⁸³ In addition, platform-based advice could enhance transparency and

⁸⁰ Morgan Stanley Research (2017), "Robo-Advice: Fintechs Enabling Incumbent Win," February, p.34.

⁸¹ BI Intelligence (2016).

⁸² Morgan Stanley (2017).

⁸³ BI Intelligence (2016). The difference in fees varies by region. While robo-advisor fees in the UK are about 90 bps (43% of traditional advisor fees) and 120 bps (47%) in the rest of Europe, this fraction is 60% in Australia and 73-88% in Hong Kong, both with robo-advisor fees of about 90 bps. It is difficult to provide exact numbers for the US market since robo-advisor fees range from 6-65 bps and traditional advisor fees from 100-225 bps, implying a ratio of 3-65%.

reduce information asymmetries and principal agent problems, depending on the process of translating the customer information into a portfolio proposal and the final investment decision.

Robo-advisors could also enhance access to financial markets for consumers. Academic research on the effects of robo-advisors on consumers finds that activity on stock markets is significantly higher with people who have access to robo-advisory tools; this effect may be driven by a reduction in perceived cost of market entry.⁸⁴ The use of robo-advisory tools could therefore spur stock market participation by private households. Though robo-advisory services are expected to increase access to wealth management for people who could not be reached by traditional asset managers (e.g. due to minimum investment barriers or high fees), the majority of growth for the robo-advisor market in terms of AuM will likely come from existing portfolios and deposits. Assumptions are that in 2020 99% of assets managed by robo-advisors will be investments done by people who already have assets under management with traditional asset managers.⁸⁵

Robo-advisory firms could pressure incumbents to reduce costs and pricing. With robo-advisory services potentially becoming mainstream in the next few years and their cost and pricing advantage over traditional wealth management, there could be competitive demands on traditional asset managers to reduce costs and make pricing more competitive. This might enhance the efficiency of the financial system as a whole. Thus, the growth of robo-advisors may erode overall asset management revenue,⁸⁶ which might benefit consumers.

Potential to undermine financial stability

There are a number of microfinancial risks:

- **Maturity and liquidity risks.** To the extent that robo-advisors only intermediate funds between customers and issuers or managers of financial products they do not tend to incur maturity or liquidity risks.
- **Operational risk.** If robo-advisory tools were to become a widespread phenomenon, operational risk (e.g. errors or functional disruptions in the algorithms to the extent they are similar across different advisors or if a small number of robo-advisors had significant market share) may arise and could like-wise have systemic implications.
- **Legal risk.** Depending on the jurisdiction, legal liability for potential mis-selling due to inappropriate advice could be on a larger scale than in traditional asset management as a flawed process could potentially affect many more consumers. Conversely, the prevalence of robo-advisory platforms could allow regulators to more efficiently review the appropriateness of the implementation of regulatory guidelines on advice by firms across a broader set of investors.

Similarly, rising levels of automation might imply potential financial stability risks associated with robo-advisory services. If robo-advisors were to use similar algorithms, they might trigger

⁸⁴ Sebastian Scheuerle (2016), “Can robo-advice spur stock market participation?” Goethe University, Frankfurt am Main.

⁸⁵ BI Intelligence (2016).

⁸⁶ A.T. Kearney (2015), “[Robo-Advisory Service Study](#),” June.

an increased incidence of unidirectional portfolio shifts.⁸⁷ If robo-advisors acquire substantial market share, such herding behaviour may drive changes in asset prices that are not justified by fundamentals.⁸⁸ An increased speed of transactions due to technological advances, possibly in combination with automated tools like smart contracts, could further fuel pricing spirals.

Box B: Robo-Advice in Germany

In 2015, robo-advisors in Germany had €170 million of AuM.⁸⁹ This amounts to less than 0.01% of AuM of the German open-ended funds industry. Up to the end of 2015, intermediated assets of robo-advisors operating in Germany have grown at a CAGR of 1200%. Currently there are about 25 robo-advisors offering services in Germany. A large share of AuM is intermediated through robo-advisors investing in ETFs. Yet some providers also offer investments in equities or equity funds or have the licence to do so.

The high degree of automation and low cost structure associated with ETFs enable robo-advisors to charge much lower fees than traditional fund managers. This is often in the form of so-called “all-in fees,” which comprise the account maintenance fee, the deposit fee as well as costs for asset management and securities transactions. In Germany, robo-advisor fees range from 0.15% to 0.99% of invested money plus an extra charge for costs arising from the underlying ETF(s) (usually 0.25%). A few providers also demand profit sharing amounting to 10%. Convenient handling and a low cost structure that gives younger people and low- or middle-income wage earners the opportunity to invest, may allow robo-advisors to tap a client potential not previously reached by traditional asset managers. Therefore, the high growth rates of the robo-advisory sector may well persist.⁹⁰

Regulatory approach in Germany

No blanket statement can be made about the authorisation requirements in Germany for providers of automated investment advice, investment or contract brokering and automated portfolio management (robo-advisory services). Regulatory requirements depend on how each online platform is set up. Automated portfolio managers, for example – just like investment advice or investment or contract brokering – must be authorised by BaFin pursuant to Section 32 (1) of the Banking Act, and are supervised as a financial service institution. Without this authorisation, robo-advisory services are generally prohibited in these business lines unless they are able to use the exemption provided for in the Banking Act. For example, exceptions may apply to financial services providers pursuant to Section 2 (6) No 8e of the Banking Act if they only engage in investment advice or investment brokering between customers and suppliers or issuers of financial instruments pursuant to Section 1 (2) of the Capital Investment Act if the latter consist of investment fund shares. The Securities Trading Act sets out further obligations to which firms might also need to adhere.

⁸⁷ ESMA, EBA and EIOPA (2015), “[Joint Committee Discussion Paper on automation in financial advice](#),” December, p. 27. In the general asset management context, some relevant frictions due to the interplay between risk-averse households and risk-neutral asset managers are also discussed in Stephen Morris and Hyun Song Shin (2014), “Risk-taking channel of monetary policy: A global game approach,” mimeo, Princeton University. We note, however, that we found no empirical evidence so far on convergence of robo-advisors’ algorithms or portfolios.

⁸⁸ See for example, Chapter 6 of Brunnermeier, Markus K. (2001), “Asset pricing under asymmetric information: bubbles, crashes, technical analysis, and herding,” Oxford University Press; or Chapters 10 and 11 of Shiller, Robert J. (2015) “Irrational Exuberance,” Princeton University Press, 3rd edition.

⁸⁹ Gregor Dorfleitner, Lars Hornuf, Matthias Schmitt and Martina Weber, (2016), “[The Fintech Market in Germany](#),” Study for the German Ministry of Finance, October.

⁹⁰ KPMG (2016), “[Robo-Advising – Catching Up and Getting Ahead](#),” January.

Annex E – Case study on DLT-based wholesale payment systems

Description

Wholesale payments generally refer to payments between financial institutions.⁹¹ They tend to be of a high value and are usually time critical (i.e. the payments need to be settled on a particular day or by a particular time). Wholesale payments make up a small share of the total number of payments, but owing to their high value,⁹² their orderly settlement is essential to a stable financial market. One main category of the wholesale payment system is real time gross settlement (RTGS) systems.⁹³ A RTGS system effects final settlement of interbank funds transfers on a continuous, transaction-by-transaction basis throughout the processing day.⁹⁴ Due to the scale of transactions on an RTGS system, any RTGS system must be designed to have adequate robustness to maintain financial stability. However, many of the issues flagged for RTGS systems may be relevant for other FMIs.

DLT may have the potential to change the way recordkeeping, accounting, payment, settlement, and other key aspects of financial markets are carried out. Some argue that the technology can offer benefits such as increased transparency and reduced counterparty risk.⁹⁵ One important development is that the technology has expanded beyond mere transaction registries to include smart contracts (i.e. other forms of data and encoded business logic).⁹⁶ DLT can synchronise the record of ownership and provide a common workflow for processing that data, ensuring that the results of agreements are processed in the same, mutually agreed manner. Smart contracts are meant to automate the performance of agreements on the basis that any outcome of the smart contract code is necessarily what parties have intended and hence achieve efficiency of contractual performance.⁹⁷ However, some legal issues (such as confidentiality of contractual terms and dispute resolution) in certain DLT models could be problematic.

Several central banks are analysing DLT for wholesale payments. In 2016, a number of central banks commenced experiments or proofs of concept (POC) to study the viability of adopting DLT as the technology underlying the RTGS. Some notable examples of such projects are those led by the Bank of Canada, Bank of England, Bank of Japan, the European Central Bank and the Monetary Authority of Singapore. A summary of these projects can be found in

⁹¹ Tom Kokkola (ed.) (2010), "[Payments, securities and derivatives, and the role of the Eurosystem](#)," September, p. 27.

⁹² For example, on an average day, RTGS settles around £500 billion between banks; that is almost a third of the UK's annual GDP every single day. See <http://www.bankofengland.co.uk/publications/Pages/speeches/2016/878.aspx>.

⁹³ The analysis would apply equally to deferred net settlement systems.

⁹⁴ CPMI (1997), "[Real-time gross settlement systems](#)," March.

⁹⁵ The published literature explaining the basics of DLT or blockchain is extensive. However, KPMG has produced a walkthrough diagram that neatly explains the essential elements of a DLT system at a glance. See Figure 1 in KPMG (2016), "[Consensus: Immutable agreement for the Internet of value](#)," June.

⁹⁶ Digital Asset Holdings (2016), "[The Digital Asset Platform: Non-technical White Paper](#)," December.

⁹⁷ For example, Ethereum supports a number of smart contract languages that allow agreements to be written in code that can be executed automatically by the network. These self-enforcing agreements independently control and automate the exchange of escrowed value according to predetermined rules based on predefined inputs. This is a notable feature, as all smart contracts on Ethereum have to be executed by multiple participants in the network, including and especially those not party to the contract. Thus, any third-party can view all transactions as well as know the exact terms of those contracts. See Digital Asset Holdings (2016), p. 5.

Box C. A number of central banks, including the ECB, Bank of England, and the Bank of Canada, have publicly stated that the next generation of RTGS will not be based on DLT.

Box C: Central bank analysis of DLT for RTGS

Bank of Canada (BoC) proof of concept

The BoC is undertaking a project to build a POC of a wholesale interbank payment system using a distributed ledger. Advised by the R3 consortium, with the nation's largest commercial lenders, Payments Canada and the Bank of Canada are working on ways to use DLT for money transfers, record keeping and other back-end functions.⁹⁸

Bank of England (BoE) RTGS review and consultation paper

The BoE began consultation on the next generation of RTGS service in September 2016. This consultation followed an extensive study commissioned by the BoE after the October 2014 CHAPS outage. In the consultation paper on the next generation of RTGS, the BoE considered the possibility of leveraging on DLT in the revamp of the current RTGS system. The BoE envisages that DLT is potentially relevant in three contexts: (i) as a possible platform for core RTGS settlement; (ii) as a platform for externally-managed securities settlement DvP or foreign exchange PvP services that require access to central bank money; and, (iii) as a platform for a possible future digital currency that might need to interoperate with RTGS. In May 2017, the BoE announced the blueprint for the new RTGS, which will not be based on DLT, but will be designed to interface with DLT in the future.

Monetary Authority of Singapore (MAS) proof of concept

The MAS announced in November 2016 that it was embarking on a collaborative project with the industry to explore the use of DLT for clearing and settlement of payments and securities. The project aims to help MAS and the industry better understand the technology and the potential benefits it may bring through practical experimentation. This is with the eventual goal of developing simpler to use and more efficient alternatives to today's systems based on digital central bank issued tokens. Phase 1, which focused on conducting domestic inter-bank payments using DLT, achieved the objectives of producing a digital representation of the Singapore dollar for interbank settlement, testing methods of connecting bank systems to a DLT, and making the MAS Electronic Payment System (MEPS+) interoperate with the DLT for automated collateral management.⁹⁹ The next phases of the POC would focus on developing mechanisms for queuing and liquidity savings and gridlock resolution, improving fixed-income securities trading and settlement, and cross-border payments through the use of central bank issued digital currency.

ECB and Bank of Japan research project on DLT

In December 2016, the Bank of Japan and the ECB launch a joint research project on distributed ledger technology. The two institutions jointly study the possible use of DLT for market infrastructure. In a first step, practical experience is gained with DLT to analyse whether liquidity-saving features of RTGS systems (TARGET2 and BOJ-NET) can run in a DLT environment in a safe and efficient manner.

⁹⁸ Bank of Canada (2017), "[Project Jasper: Are Distributed Wholesale Payment Systems Feasible yet?](#)" Financial System Review, June.

⁹⁹ Deloitte and Monetary Authority of Singapore (2017), "[The future is here: Project Ubin: SGD on Distributed Ledger.](#)"

Potential to support financial stability

The potential benefits of DLT for wholesale payments are theoretical. While this section will draw on benefits put forward by proponents of DLT, it should be noted that no central bank has implemented a major DLT solution outside of a POC. Moreover, there is little analysis on whether the merits of RTGS supported by a traditional centralised technology infrastructure may be similarly achieved by a DLT solution.¹⁰⁰ The success of any DLT solution implementation will depend on testing and experimentation.

Some potential benefits of DLT identified by academics and financial institutions¹⁰¹ are efficiency, transparency, trust and resilience.¹⁰² The proponents argue that mutual agreement about the state of important information is maintained without additional reconciliation, and smart contracts may be used to speed up performance of contracts, thereby creating efficiency. Some information is replicated to all participants in real time, enabling a high degree of transparency and the ability to prevent logical conflicts. In most DLT systems, a quorum of the relevant participants need to agree on data being added before it becomes part of the ledger. This is very different from central ledgers held and controlled centrally. Some are of the view that trust between participants in the system is strengthened when multiple parties have a say over what data is written. Finally, the resilience of a DLT system stems from the distributed nature of its design, and could increase with the number of DLT participants. Consistent data stored in a distributed system can be more robust against corruption and have greater longevity.

For wholesale payments, resilience might be a key benefit. The most essential trait of a RTGS is reliability, and thus evaluating the reliability of potentially new infrastructure must be done with great care.¹⁰³ The resilience of a DLT solution is founded on the distributed nature of the ledger, which mitigates the “single point of failure” of data storage as every node maintains the same set of data. The nodes are constantly available for examination of an audit trail of transactional history, which can be traced back to the moment when a piece of transactional information was created.¹⁰⁴ Moreover, for most DLT systems, the majority of participants in a DLT solution will need to agree before any transaction can be recorded on the distributed ledger. This requires compromise of many parties before cyber-attacks on the DLT solution can succeed. Finally, the use of cryptography and digital signatures to prove identity and authenticity and to enforce read and write access rights gives the DLT solution added robustness.

Potential to undermine financial stability

It is not clear whether such a system would be sufficiently robust to support the volume and intensity of current RTGS transactions. Indeed, the BoE’s research¹⁰⁵ as well as

¹⁰⁰ By traditional RTGS we refer to RTGS that do not employ DLT, although we note that some may already rely on databases that are distributed, such as the EU’s TARGET2 RTGS.

¹⁰¹ Financial Conduct Authority (2017), “[Discussion Paper on Distributed Ledger Technology](#),” April.

¹⁰² See for examples, DBS Vickers Securities (2016), “[Understanding Blockchain Technology](#),” February, and KPMG (2016), “[Consensus: Immutable agreement for the Internet of value](#).”

¹⁰³ Angela Walch (2016), “[The Bitcoin Blockchain as Financial Market Infrastructure: A consideration of Operational Risk](#).”

¹⁰⁴ ASTRI (2016), “[Whitepaper On Distributed Ledger Technology](#),” commissioned by HKMA, November, p. 5.

¹⁰⁵ Bank of England (2016), “[A new RTGS service for the United Kingdom: safeguarding stability, enabling innovation](#),” p. 42.

statements by other central banks such as the ECB and the BoC has highlighted that the technology is not sufficiently mature to provide the exceptionally high levels of robustness required for RTGS settlement. The industry will need to overcome several challenges in the adoption of a DLT solution. These challenges may be broadly categorised as microfinancial risks (including operational and legal risks) and macro-financial risks (including contagion or systemic risks).

One key risk in a DLT solution is settlement finality. In post-trade clearing and settlement, settlement finality is currently a legally defined moment, typically supported by a statutory, regulatory, or contractual framework underlying a given financial transaction. Parties to a transaction and their intermediaries rely on the definition and timing of finality when they update their own ledgers to effect settlement, determine the ownership of assets, as well as measure and monitor various risks. In contrast, in a majority vote-based DLT solution, multiple parties are permissioned to update a shared ledger, and those parties must agree to a particular state of the ledger through the consensus process. Settlement in this model may only be probabilistic.¹⁰⁶ The longer a transaction is considered settled by the system participants, the less likely this transaction will be reversed. This approach to finality contrasts with the traditional approach of defining an unambiguous and transparent moment of finality. With a probabilistic approach to finality, legal liability may be difficult to assign or be ambiguous in such a network. Such legal uncertainty has implications for the balance sheets of participants as well as the rights of their customers and creditors. That said, some DLT solutions have features¹⁰⁷ that can offer more traditional guarantees of absolute finality. Some consensus algorithms fall back to the concept of notaries where the time-stamping and signature of a notary on some transactional information makes it final and commits the parties to the fulfilment of the transaction.

A fundamental viability test for new technologies like DLT is whether they can be deployed and operated safely across a wide range of adverse scenarios.¹⁰⁸ As with any system where vulnerabilities can exist within both software and hardware components, DLT may face increased exposure to cyber-attacks through its distributed network of participants, or endpoints, which are validating transactions and writing to the distributed ledger. A DLT solution is not technologically and inherently immune to cyber-attacks. The successful hacking of Bitcoin exchanges¹⁰⁹ is testament that the vulnerabilities that exist in every solution involving online transactions still need to be addressed.

Another operational challenge in a DLT solution is the strength of its cryptography. If the central bank system's encryption is compromised, a DLT solution may be particularly

¹⁰⁶ David Mills, Kathy Wang, Brendan Malone, Anjana Ravi, Jeff Marquardt, Clinton Chen, Anton Badev, Timothy Brezinski, Linda Fahy, Kimberley Liao, Vanessa Kargenian, Max Ellithorpe, Wendy Ng, and Maria Baird (2016), "[Distributed ledger technology in payments, clearing, and settlement](#)," Finance and Economics Discussion Series Division of Research & Statistics and Monetary Affairs, Federal Reserve Board.

¹⁰⁷ These include byzantine fault tolerant, or RAFT. For some explanation see Diego Ongaro and John Ousterhout (2014), "[In Search of an Understandable Consensus Algorithm](#)," in Proceedings of 2014 USENIX Annual Technical Conference, Philadelphia, PA, June 19-20: 305–319.

¹⁰⁸ Mills, et al (2016).

¹⁰⁹ For examples of reports of the collapse of Mt. Gox and Bitfinex see Robert MacMillan (2014), "[The Inside Story of Mt. Gox, Bitcoin's \\$460 Million Disaster](#)," March; David Floyd (2015), "[A \\$480 Million Mystery: The Saga of Mt. Gox](#)," August; and Reuters (2016), "[Bitcoin Worth \\$72M Was Stolen in Bitfinex Exchange Hack in Hong Kong](#)," August.

vulnerable. As risks and threats are continually evolving, the operators of a DLT solution need to ensure that the procedures and controls they use to secure DLT systems also continually assess risk, improve, and adapt, which may be particularly challenging in an open and permissionless system. Ultimately, these and other security concerns will have to be fully addressed as cryptography in principle only protects a possible attacker for some time. The stronger the encryption the more time/resources are necessary to break the protection. Thus, it must be noted that there are numerous data that are not classified to be able to be stored on blockchain. Security solutions need to be adaptable and scalable to the security needs.

Finally, there may be major systemic risks from potential gridlocks or deadlocks.¹¹⁰ This situation occurs when participants do not have sufficient liquidity to settle transactions on an individual basis, which leads to settlement queues (this is typically handled through liquidity saving mechanisms and queue management in existing RTGS systems).¹¹¹ Some commentators¹¹² have argued that a DLT solution could bring about the efficiency of batch netting and the security of gross settlement without any dependency on collateral markets.¹¹³ However, it is unclear how DLT consensus algorithms that have no specific function to control transaction sequences in a block will in practice anticipate and resolve potential gridlocks.¹¹⁴ That said, it is conceivable that such problems could be addressed through technical modifications or enhancements when there is a major deployment of a DLT solution by a central bank in replacement of its RTGS system, if and when such a decision were taken.

Overall, the implications of DLT for wholesale payments should be carefully studied. DLT solutions are still developing as a financial service instrument, and hence there is significant work to be done before strong conclusions can be drawn. It remains to be determined whether a DLT solution will be able to cope with the volume of transactions that major FMIs like an RTGS system are expected to handle, and the sophistication of operations that is required of a RTGS system. Significant challenges need to be addressed, including interoperability between platforms, identification of relevant parties, appropriate levels of privacy, and viability of upgrading the various systems over time. That said, FMIs like an RTGS system are continually fine-tuned, and where possible further efficiencies, stability and robustness in the system should be pursued and developed. Whether the DLT solution will be a suitable alternative to the current RTGS system is an area worth considering and studying further.

¹¹⁰ The formation of queues is referred to as *gridlock* if queues can be attributed to the requirement for payments to be settled individually. If the formation of queues is due to a lack of liquidity, they are referred to as *deadlocks*.

¹¹¹ Morten Bech and Kimmo Soramäki (2001), "[Gridlock Resolution in Payment Systems](#)," Bank of Finland Working Paper No. 9/2001.

¹¹² Izabella Kaminska (2016), "[RTGS, and the story of batches instead of blocks](#)," January.

¹¹³ This appears to resemble current Deferred Net Settlement (DNS) Large Value Payment Systems (LVPS).

¹¹⁴ For more detailed commentary on this point, see Atsushi Santo, Ikuo Minowa, Go Hosaka, Satoshi Hayakawa, Masafumi Kondo, Shingo Ichiki, and Yuki Kaneko (2016), "[Applicability of Distributed Ledger Technology to Capital Market Infrastructure](#)," Japan Exchange Group (JPX) Working Paper No. 15.

Annex F – Case study on private digital currencies

Description

Digital currencies (DCs) are digital representations of value, issued by private developers and typically denominated in their own unit of account.¹¹⁵ They have no paper counterpart, but rather exist only electronically. They do not have any backing by a government or central bank. Decentralised DC schemes are not operated by any specific institution and are often referred to as cryptocurrencies because of their use of cryptographic techniques.¹¹⁶ A centralised DC would represent a liability of the issuer and assets of equal value would be held on the issuer's balance sheet. Digital currencies are backed only by the users' confidence in the currency and the expectation that others will be willing to exchange it for sovereign currency or goods and services. DLT is used to execute transactions remotely through the internet.

There are currently about 700 digital currencies in existence for a total market capitalisation of around \$106 billion.¹¹⁷ Because of the relatively small size of DCs, they do not currently pose a systemic risk. Similarly, given the difficulties of a DC ever accounting for a significant proportion of transactions in a jurisdiction, the likelihood of a DC ever becoming systemically important is judged to be low. Should one or more of them achieve widespread adoption, however, various financial stability issues could emerge and are discussed below.

A new product has been proposed recently that could be denominated in a sovereign currency and backed by assets on deposit. The Universal Settlement Coin (USC) proposed by UBS and a small group of major global banks is an example of this type of instrument. Some may consider this product to be an investment asset rather than a currency. It can be traded as with other assets but is not intended as a transaction currency for the purchase of goods and services. A centralised body would manage it.

Potential to support financial stability

DCs could support access to financial services in some jurisdictions. In many jurisdictions, the share of cell phone ownership equals or exceeds the share of the population with access to a bank account. This is particularly true in emerging economies with large rural areas with little or no access to physical banks. This represents an important opportunity for the growth of DCs that allow free, or low-cost, mobile phone-based transactions. DCs are designed to promote electronic exchange of value in a trustless environment. As such, they can potentially support online trade and improved financial inclusion in regions with a lack of trust for existing monetary arrangements.

Borderless DCs also have the potential to reduce the cost of cross-border money transfers. DCs allow for anonymous exchange so are better able to protect the user from identity theft. At

¹¹⁵ Many documents have been produced on digital currencies. Just to cite a few, the analysis in this section is based in part on the following references: CPMI (2015), "[Digital currencies](#)," November; ECB (2015), "[Virtual Currency Schemes – A Further Analysis](#)," February; BoE (2014), "[The Economics of Virtual currencies](#)," Quarterly Bulletin, Q3; Carolyn Wilkins (2014), "[Money in a Digital World](#)," speech at the Wilfrid Laurier University, Waterloo, Ontario, November.

¹¹⁶ Garrick Hileman and Michel Rauchs (2017), "[Global Cryptocurrency Benchmarking Study](#)," Cambridge Centre for Alternative Finance, April.

¹¹⁷ See Cryptocurrency Market Capitalizations at <http://coinmarketcap.com/>.

the same time, DCs are quite transparent which permits the easy verification of all transaction details except for identity.

Potential to undermine financial stability

Operational risk is the main microfinancial concern emanating from DCs, especially those that are decentralised and operate with limited or no formal governance structure. It would be challenging to enforce operational requirements to ensure the efficiency and stability of a DC that has no governance structure and that allows anyone to participate as part of the infrastructure (e.g. a permissionless framework or miners). In addition, the enforcement of rules regarding KYC, and AML would be more difficult. Similarly, banks facilitating or participating in DC transactions could be at risk of violating AML and other regulations.

Individual users of DCs are exposed to risks such as the bankruptcy of key third-party service providers of the DC infrastructure. There have been several examples of failures by Bitcoin exchanges to adequately safe guard the Bitcoins of users leading to millions of dollars of losses. The exchange rate between DCs and fiat currencies also tends to be much more volatile than other exchange rates, which exposes users to a high degree of market risk. Should a market crash occur after a DC becomes wide spread, there would be major losses to holders and a significant possibility of reputational contagion effects between DCs and from the DC to other asset markets. A run on a DC (or several DCs) could not be ruled out, adding to exchange-rate volatility vis-à-vis the central bank issued currency. Merchants and financial institutions could also begin refusing to accept payment DC during periods of reduced confidence. Authorities, however, would have a more limited ability to supply DC-denominated liquidity to the market place through conventional facilities and restore confidence in the DC.

Widespread use of DCs could disintermediate existing payment services infrastructure. This could inhibit the ability of current payment infrastructures from offering the same efficient and stable service it does now. Oversight of a DC would be inherently more difficult given its international, borderless nature.

Similarly, widespread use might erode central bank control over monetary policy and the economy and reduce the strength or effectiveness of lender-of-last-resort (LOLR) interventions. This has direct implications for financial stability since monetary policy actions contribute positively to financial stability, at least over the typical business cycle. Central bank control over the DC portion of the economy would be especially limited if the DC and non-DC segments of the economy were segregated and if the sovereign currency segment became small, unless there were a means by which the central bank could ensure full pass-through of policy-rate changes to DC-denominated lending and asset prices. While such a set-up may be possible, in principle, through novel open-market interventions, it could force the question of whether the central bank should hold large reserves of DC-denominated assets, which could expose the central bank's balance sheet to undue risk. Absent such a novel setup, the problem would be analogous to the dollarisation issue. Domestic monetary policy is weakened the greater the dollarisation of the economy. If the sovereign currency economy becomes small, the situation would be similar to that of a small open economy having no or limited effect on a large trading partner. The lack of monetary stability would reduce the central bank efforts to create financial stability.

There may be new liquidity risks. The money that flows into a DC comes from both physical cash and from transaction deposits at financial institutions, as well as from conversion of one digital currency to another. With fewer of these typically stable and secure funding deposits, banks may become riskier. The net stable funding ratio, which is a core component of current banking regulations, would deteriorate if banks would rely more heavily on riskier deposits or wholesale funding. Users of the DC would also be substituting a government-insured deposit for an uninsured DC. The DC could thus be more susceptible to runs compared to the bank. To prevent such instability, a high degree of oversight and regulation of the system would likely be required, as argued by research on the historical episode in Canada and the US when private and sovereign bank notes circulated side by side.¹¹⁸ There is also a potential moral hazard problem should a private DC become systemically important. DCs that follow mechanistic supply rules may pose less moral hazard risk but other DCs may emerge with flexible supply but a lack of proper governance to curtail this type of risk.

¹¹⁸ Ben Fung, Scott Hendry and Warren Weber (2017), "[Canadian Bank Notes and Dominion Notes: Lessons for Digital Currencies](#)," Bank of Canada WP 2017-5; Warren Weber (2015), "[Government and Private E-Money-Like Systems: Federal Reserve Notes and National Bank Notes](#)" Bank of Canada WP 2015-18.

Annex G – Case study on AI and machine learning

Description

Big data analytics is a broad category of tools that includes AI, machine learning and, more recently, deep learning. AI can be broadly defined as “human intelligence exhibited by machines.” Machine learning is a type of AI that provides computers with the ability to learn without being explicitly programmed.¹¹⁹ One example is the identification of spam based on user feedback. Finally, “deep learning” is a field of machine learning that uses many layers of learning algorithms to derive meaning out of large quantities of data. Example applications include image recognition and natural language processing (NLP). Many advances in AI and machine learning are essentially advanced statistics, automatically applied to evolving datasets. Unsupervised learning is an a-theoretical method, which lets programs identify relationships that would otherwise be difficult to observe.

A confluence of factors has led to a resurgence of AI in a variety of sectors, including financial services. Some factors identified include: i) affordable parallel computing, which allows distribution of processes; ii) faster processors, such as graphical processing units (GPUs); iii) cheaper data storage; iv) bigger and more granular data sets due to “digitizing everything;” and v) better algorithms. Together, these have helped make possible a number of innovations, such as the self-driving car and digital personal assistants. Some applications aim at “augmented intelligence,” or machine assistance to human cognition.

AI and machine learning are already being applied to a range of services for financial institutions by both incumbents and third-party providers. Some firms use AI for AML and fraud detection at financial institutions. Firms can use machine learning for credit monitoring, risk mitigation as well as fraud monitoring in banking. Some AI and machine learning enabled technologies can be applied to financial regulation, supervision, systemic risk surveillance and oversight or audit functions. Examples include top-down stress-testing or methods for simplifying regulatory reporting by institutions. Banks may use AI and machine learning for asset pricing, credit risk modelling, back-office operations, marketing and even in human resources processes. Some are using AI to monitor internal conduct breaches, such as rogue traders.

The FSB is conducting ongoing monitoring of AI and machine learning in financial services. This work draws on discussions with private sector participants, analysis by professional services firms and academic research. This annex gives initial findings from this work. These findings are necessarily preliminary and subject to change as the analysis progresses.

Financial stability implications of AI and machine learning depend heavily on the use case. Hence, the benefits or risks of AI and machine learning will also depend on how and in which financial markets or products the technologies are used. Because these use cases are constantly changing and evolving, it will be important to keep abreast of major market developments and applications.

¹¹⁹ Michael Jordan and Tom Mitchell (2015), “Machine learning: Trends, perspectives, and prospects,” *Science* 349(6245): 255–260.

Potential to support financial stability

Key potential benefits include various applications of AI and machine learning in supervision, internal audit and regulatory reporting, as well as the ability to better monitor risks. AI can offer compliance oversight tools; enhanced data simulations for institutions and across markets; real-time connectivity to monitor and respond to risks; and it can help address complexity challenges at large institutions (e.g. “too complex to manage”). These applications can help financial institutions, as well as supervisors, better understand causal relationships and better manage risks, and regulatory compliance. Moreover, AI and machine learning can aid supervision by allowing the identification of new relationships in data, without the filter of pre-specified models. Many new tools (e.g. AML or stress test applications) are useful for financial institutions, markets, and policymakers.

Potential to undermine financial stability

Key risks include the opacity and lack of auditability of algorithms (in case of “black boxes”) and undesired changes to market structure. Given the current practice of model validation at banks or other financial service providers, in which risk models have strict governance rules and must be explained in detail to regulators, there may be problems if banks or other financial service providers apply AI models. Specifically, the “auditability” of the models might be difficult to achieve and not ensured in all cases. In some cases, firms may be simulating the outcomes of AI models in traditional models or restrict themselves to a smaller set of AI approaches that do not suffer from “black box” problems. Moreover, for some applications, such as trading and portfolio management employing investment strategies based on AI, there is the potential for new interconnections and new, unforeseen risks in market trading behaviour.

There may be challenges for regulation. The growing role of non-financial firms offering AI applications for financial services could present challenges for existing regulatory structures. In some cases, regulators are themselves experimenting with AI and machine learning to stay informed of developments and aid policy. Yet there are concerns that financial institutions might have more information and or expertise than the supervisor, and it might be a challenge to stay up to speed.

Annex H – Stocktake of regulatory approaches to FinTech

This annex draws out selected issues and commonalities from the FSB stocktake of regulatory approaches to FinTech. Key points are as follows:

- A majority (20 of 26) of jurisdictions have taken or plan to take measures on FinTech. Other jurisdictions are considering changes, and one has chosen not to make changes.
- Policy objectives are mostly consumer protection, market integrity, financial inclusion and promoting innovation or competition; financial stability is mentioned less often.
- Many changes focus on crowdfunding / FinTech credit, virtual currencies, payments, cybersecurity, or in some cases specific technologies (e.g. big data, cloud computing).
- Data availability is frequently mentioned as an issue, and there are sometimes legal or institutional constraints on action. Cross-border issues are not frequently discussed, largely because authorities are focused on domestic issues and mandates.

Context and policy objectives

The FIG surveyed 26 jurisdictions on their regulatory approach to FinTech.¹²⁰ A written survey was launched on 3 February 2017 to collect information on: (i) whether authorities had adapted existing or issued new regulations in response to FinTech; (ii) whether they are planning to change or issue new regulation; (iii) whether after review they have decided to make no changes; (iv) whether the approach to regulation is more principles-based or more rules-based; (v) whether they have seen any changes in market structure due to FinTech; and (vi) any lessons learned. A roundtable with national authorities and relevant international organisations was held on 9 March 2017 in Singapore to delve more deeply into these topics, with 13 jurisdictions elaborating on their regulatory approaches to FinTech.

A majority of jurisdictions (20) have already taken some measures to respond to FinTech. A further five jurisdictions have not yet made changes but plan to do so, and one (Saudi Arabia) has found that changes are not needed at this time. Within jurisdictions, there are also different areas where changes have been made, and others where changes are either planned or are not foreseen after a review. The scale of changes or planned changes varied substantially, from a new Draft Law in Mexico and eight new sets of rules or opinions in China, to more minor amendments to existing rules or law in Korea, the EU, Switzerland, Turkey and Russia. Moreover, jurisdictions including Argentina, Hong Kong, India, Indonesia, Pakistan and Singapore have issued specific rules¹²¹ in different areas. Meanwhile, some regulatory authorities in Canada, Germany and the US have recently issued publications or proposals on aspects of FinTech.

Policy objectives most commonly include consumer protection, market integrity, and financial inclusion as well as promoting innovation or competition. Many jurisdictions are targeting multiple policy objectives. Of the 20 jurisdictions that provided information on the intended outcomes, 17 named consumer (investor or borrower) protection as a policy objective,

¹²⁰ All 24 FSB member jurisdictions, plus Kenya and Pakistan. The European Commission also completed the survey.

¹²¹ In Singapore, MAS issued guidelines for internet banking and technology risk management as well as cloud outsourcing guidelines.

13 stated fostering innovation, 12 identified competition, 10 mentioned financial inclusion or access, and nine mentioned market integrity or AML/CFT.

Financial stability is mentioned less frequently. Only eight jurisdictions explicitly mentioned financial stability or stable markets as a key policy consideration to date. In part, the focus on consumer protection and integrity rather than financial stability may reflect the early phase of development of many innovations. At the same time, protecting consumers and investors can be seen as having relevance to financial stability. Because most activities are small in volume, regulation is most relevant currently at the micro, rather than macro level. Moreover, many authorities see the assurance of market integrity and trust as important foundations that are essential for the sustainable growth of FinTech markets.

Recent and planned changes to regulatory frameworks

Changes to-date are generally focused on specific areas, such as crowdfunding and FinTech credit, virtual currencies, payments or cybersecurity. At least 15 jurisdictions have issued or plan to issue rules or guidance on crowdfunding or FinTech credit. Due to important differences with existing business models for lending and equity issuance (such as the higher number of investors), some jurisdictions have found it necessary to amend existing regulation, sometimes defining new licensing requirements or clarifying where existing rules continue to apply. For virtual currencies, there are moves to clarify the legal framework for storing or transferring value and addressing risks of fraud or money laundering. For payments (13 jurisdictions), authorities aim to ensure greater access to payments services for retail clients, and to ensure smooth functioning of the payments systems, in line with existing responsibilities for payments infrastructure. On cybersecurity (mentioned by five jurisdictions), there are public warnings by some authorities on a change in risks due to FinTech, and on the stability risks of cyber-attacks more generally.

To guide innovation and experimentation, 14 jurisdictions have or are planning innovation facilitators. Among those jurisdictions, the most common model is the “regulatory sandbox,” where new products or services can be tested in a (controlled) environment. This is used by the Australia, Canada, Hong Kong, Korea, Netherlands, Singapore and the UK, while Mexico, Turkey and Saudi Arabia are considering this model, and Indonesia is in the process of establishing a regulatory sandbox. Another model involves innovation hubs, like the FinTech Support Desk in Japan, the Fintech Center in Korea, or hubs in Brazil and France; this model involves support to firms to navigate the regulatory requirements. Finally, some jurisdictions have an accelerator, or partnership arrangements between innovators, incumbent firms and/or public sector authorities to ‘accelerate’ growth or develop use cases. This model is used by the BoE and Monetary Authority of Singapore (MAS).¹²² Finally, authorities have regular outreach with the sector. In China, for example, this is aided by the National Internet Finance Association (NIFA), which guides and supervises the implementation of national policies.

Some authorities are going deeper into the details of the technologies, themselves. In Canada, FINTRAC has issued methods to ascertain the identity of individual clients, and in Korea, guidelines have been issued on de-identification of personal information to facilitate use

¹²² These innovation facilitators have been studied in more detail by the FSB Financial Innovation Network (FIN) and BCBS Task Force on Financial Technology (TFFT) in their August 2016 “Stocktaking of members’ use of innovation facilitators.” [unpublished].

of big data. In Singapore, MAS issued guidance on prudent risk management practices for outsourcing, including cloud computing services. In France, laws were modified in 2016 for using DLT for minibonds and non-listed equities to allow experimentation with DLT.

Further observations

Data availability is a nearly universal issue. While the abundance of data is itself at the heart of FinTech developments, regulators often note having few official data sources to monitor the sector, in part because entities fall outside the regulatory perimeter or are not registered to participate in sandboxes, innovation hubs, or accelerators. Some entities may even fall under the regulatory perimeter but have few or no financial reporting obligations due to, for instance, their small size or because they are registered under licences that involve fewer reporting requirements than full banking licences. Instead, many authorities use private sector, academic or consultant estimations for monitoring. In some cases, a sandbox or innovation hub can be an important source of data for regulators.

Many authorities report having both a principles-based and rules-based approach. In some authorities' view, because of the nascent nature of many activities, it can be difficult to be very prescriptive in specific rules. As such, some authorities are moving to a more principles-based framework. For example, the legal framework in Mexico follows a rules-based approach, but due to the dynamics of the FinTech industry, the Draft Law and resulting regulation contemplates moving to a principles' based approach. In other cases, there continues to be both principles-based and rules-based elements.

In some cases, there are legal and institutional constraints to policy. Twelve jurisdictions mention specific constraints, such as the slow movement of the legislative process, institutional fragmentation, and a broad range of business models in FinTech. Other jurisdictions report no particular constraints.

Cross-border issues may be relevant, but are not yet universally discussed. In several jurisdictions, frameworks are currently targeted at domestic market participants. Brazil and Singapore mention the use of FinTech for remittances, where issues pertaining to cross-border payments, such as licensing of foreign-based service providers, would require further discussion. In some cases, regional cooperation is a relevant factor. For example, in the EU, domestic and other EU market participants are often considered on an equal footing; a similar framework applies for the East African region (of which Kenya is a part). Canada and Turkey mention the need to deal with AML/CFT issues or illegal transactions, while Indonesia has tailored rules to encourage the inflow of foreign capital, which are subject to the AML/CFT rules. More generally, it is clear that authorities primarily consider domestic mandates for policy. However, given the virtual footprint of many innovations, cross-border issues may grow in importance as FinTech develops.

Annex I – Members of the FSB FinTech Issues Group

Chair	Carolyn Wilkins Senior Deputy Governor Bank of Canada
Australia	Julie Greenall-Ota Principal Adviser - Financial System Division, Markets Group Australian Treasury
Canada	Stephen Murchison Advisor to the Senior Deputy Governor Bank of Canada
China	Liao Yuanyuan Deputy Director General of Policy Research Bureau China Banking Regulation Commission Lin Ran Director of G20 Division, International Department People's Bank of China
Germany	Corinna Knobloch Head of Section Systemic Risks in the Shadow Banking System and Financial Innovation Deutsche Bundesbank Thomas Thran Head of Digitalization Network IFR and Senior Officer International Insurance Policy BaFin
Mexico	Bernardo González Rosas Assistant Secretary for Banking, Securities and Savings Mexican Ministry of Finance and Public Credit
Netherlands	Reinier Pollmann Programme Manager Innovation & Fintech Netherlands Authority for Financial Markets
Singapore	Tan Yeow Seng Executive Director, Technology Risk and Payments Department Monetary Authority of Singapore
South Africa	Arif Ismail Head, Oversight of National Payment Systems Department South African Reserve Bank
Switzerland	Rene Weber Head, Markets Division State Secretariat for International Financial Matters (SIF)

United Kingdom	Nicola Anderson Director, Financial Stability Strategy and Risk Bank of England
	Bob Ferguson Head, Innovation Hub Financial Conduct Authority
United States	Igor Kozhanov Financial Economist, Division of Economic and Risk Analysis Securities and Exchange Commission
CPMI	Klaus Loeber Senior Advisor, Market Infrastructure and Payments (European Central Bank)
European Commission	Peter Kerstens Head of Financial Technology Task Force
SCAV Financial Innovation Network	John Schindler Chair of Financial Innovation Network (FIN) (Federal Reserve Board)
FSB Secretariat	Grace Sone Member of the Secretariat
	Jon Frost Member of the Secretariat