FSB FINANCIAL STABILITY BOARD

FinTech and market structure in financial services:

Market developments and potential financial stability implications

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Executive summary

Technological innovation holds great promise for the provision of financial services, with the potential to increase market access, the range of product offerings, and convenience while also lowering costs to clients. At the same time, new entrants into the financial services space, including FinTech firms and large, established technology companies ('BigTech'), could materially alter the universe of financial services providers.[1] This could in turn affect the degree of concentration and contestability in financial services, with both potential benefits and risks for financial stability.

Greater competition and diversity in lending, payments, insurance, trading, and other areas of financial services can create a more efficient and resilient financial system. Notwithstanding these clear benefits to financial stability, heightened competition could also put pressure on financial institutions' profitability. This could lead to additional risk taking among incumbents in order to maintain margins. Moreover, there could be new implications for financial stability from BigTech in finance and greater third-party dependencies.

While markets have developed differently across jurisdictions, there are commonalities that warrant international discussion. While these commonalities may be global in scope, their impact on each jurisdiction depends on the state of development of the financial services industry and the regulatory environment. Some key considerations from the FSB's analysis of the link between technological innovation and market structure are the following:

- To date, the relationship between incumbent financial institutions and FinTech firms appears to be largely complementary and cooperative in nature. FinTech firms have generally not had sufficient access to the low-cost funding or the customer base necessary to pose a serious competitive threat to established financial institutions in mature financial market segments. Partnering allows FinTech firms to viably operate while still being relatively small and, depending on the jurisdiction and the business model, unburdened by some financial regulation while still benefitting from access to incumbents' client base. At the same time, incumbents benefit from access to innovative technologies that provide a competitive edge.
- Yet there are exceptions to this trend, as some FinTech firms have established inroads in credit provision and payments. FinTech credit is growing rapidly, but is still small as a proportion of overall credit in most jurisdictions. To the extent that technology permits a further unbundling of profitable services traditionally offered by banks and other institutions, the profitability of such institutions may be negatively affected in the future.
- The competitive impact of BigTech may be greater than that of FinTech firms. BigTech firms typically have large, established customer networks and enjoy name recognition and trust. In many cases, these companies could also use proprietary customer data

[1] The FSB defines FinTech 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." FinTech firms is used here to describe firms whose business model focuses on these innovations. BigTech firms refers here to large technology companies that expand into the direct provision of financial services or of products very similar to financial products. The glossary provides an overview of terms used in the document.

generated through other services such as social media to help tailor their offerings to individual customers' preferences. Combined with strong financial positions and access to low-cost capital, BigTech firms could achieve scale very quickly in financial services. This would be particularly true where network effects are present, such as in payments and settlements, lending, and potentially in insurance. Cross-subsidisation could allow BigTech firms to operate with lower margins and gain greater market share. Hence, while BigTech firms could represent a source of increased competition for incumbent financial institutions, in some scenarios, their participation may not result in a more competitive market over the longer term. A greater market share of BigTech may be associated with unchanged or higher concentration, along with a change in composition away from traditional players. A striking example is the mobile payments market in China, where two firms account for 94% of the overall market.

- Reliance by financial institutions on third-party data service providers (e.g. data provision, cloud storage and analytics, and physical connectivity) for core operations is currently estimated to be low. However, following the trend in other industries, some analysts predict that reliance will increase going forward. If high reliance were to emerge, along with a high degree of concentration among service providers, then an operational failure, cyber incident, or insolvency could disrupt the activities of multiple financial institutions. Thus, while increased reliance on third-party providers specialising in cloud services may reduce operational risk at the individual firm level (idiosyncratic risk), it could also pose new risks and challenges for the financial system as a whole, particularly if risks are not appropriately managed at the firm level, and if the complexities and interconnectedness of third parties and their usage continue to grow. This was noted in the conclusions of the FSB's 2017 report on FinTech to the G20,[2] and remains an issue for authorities to consider.

As FinTech firms, BigTech firms, and the markets for third-party services continue to develop, it will be important to continue monitoring these developments and their financial stability implications. Further efforts on third-party dependencies are ongoing in the Basel Committee on Banking Supervision (BCBS) and International Organization of Securities Commissions (IOSCO). The FSB Financial Innovation Network (FIN) is further exploring the market for third-party services for financial institutions, including how they manage lock-in risk and cross-border issues. Moreover, FIN is looking into the activities of BigTech in finance, including cross-border activities.

[2] FSB (2017a), "Financial Stability Implications from FinTech: Supervisory and Regulatory Issues that Merit Authorities Attention," June.

1. Background and definitions

FinTech might affect financial stability by changing the market structure in financial services. As used in this report, market structure refers to the interrelation of companies in a market that impacts their behaviour and their ability to make profits. Market structure is characterised by such factors as the number and size of market participants, barriers to entry and exit, and accessibility of information and technologies to all participants.[3] In certain speculative scenarios, these in turn may have an impact on the stability of the financial system. Financial innovation could influence market structure in financial services through different channels, including the following:

(i) The emergence of providers of bank-like services such as FinTech credit[4] or payments, which may impact markets and bank behaviour. The greater efficiency of new players may enhance the efficiency of financial services in the longer term. The absence of legacy systems also may favour new entrants.[5] These trends could have an impact on the revenue bases of banks and other incumbent financial institutions, making them potentially more profitable in some instances, or potentially more vulnerable to losses and reducing retained earnings as a source of internal capital. This could have an impact financial sector resilience and risk-taking. The speed at which new providers enter the sector could be a critical factor in determining how well incumbents adjust.

(ii) The entry of large, well-established technology firms into financial services ('BigTech').[6] Non-traditional institutions with established networks and accumulated big data have gained a foothold in financial services space in some jurisdictions, particularly in payments, and in some cases in credit, insurance, and wealth management. This too, could be a source of increased competition with established financial institutions. New BigTech players could offer lower-cost (or even free) services, since they could use the data obtained through these services for a variety of businesses. This in turn could also have a range of effects on existing markets.

(iii) The provision of important services by third parties.[7] Financial institutions rely on third-party service providers for data provision, physical connectivity, and cloud services. The reliance of traditional financial institutions and FinTech firms on third-party service providers may increase over time. Systemic operational and cyber security risks may

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3 See FSB (2016), "Fintech: Describing the Landscape and a Framework for Analysis," March; and FSB (2017a).

4 CGFS and FSB (2017), "FinTech Credit: Market developments, business models and financial stability implications," May.

5 See e.g. Kai Riemer, Ella Hafermalz, Armin Roosen, Nicolas Boussand, Hind El Aoufi, David Mo, Sudhir Pai, and Alex Kosheliev (2017), "The FinTech Advantage: Harnessing digital technology, keeping the customer in focus," Capgemini and Sydney Business School, for a description of these factors in the Australian financial sector.

6 See Dirk Zetzsche, Ross Buckley, Douglas Arner and Janos Barberis (2018), "From FinTech to TechFin: The Regulatory Challenges of Data-Driven Finance," New York University Journal of Law and Business, Forthcoming; Agustín Carstens (2018), "Big tech in finance and new challenges for public policy," speech at FT Banking Summit, 4 December.

7 For an overview of such dependencies prior to the global financial crisis, see Committee on Payment and Settlement Systems (CPSS) (2008), "The interdependencies of payment and settlement systems," June. For a more recent perspective on risks from such dependencies for banks, see OCC (2017), "Semiannual Risk Perspective," Fall, pp. 14-15.

arise if systemically important institutions or markets do not appropriately manage risks associated with third party outsourcing at the firm level.[8]

Meanwhile, a shift in regulation towards 'open banking,'[9] facilitated by changes in both technology and consumer preferences, could mean greater competition in certain services while also posing new risks. The combined effect of these developments may be far-reaching.

This report considers changes in market structure in financial services due to technological innovation, and explores the potential impacts of these developments on financial stability.[10] Key elements of market structure for the purpose of this paper are **concentration** (the extent to which the industry is dominated by a small number of large firms), **contestability** (the extent to which the threat of new entrants leads to behaviour that resembles a more competitive market), and **composition** (the characteristics of market participants). Market structure is most often considered with reference to its effects on competition, but it may also be relevant to financial stability. Some studies find a non-linear link between competition among financial institutions and financial stability. In particular, they find that both very concentrated markets and very strong competition can be tied to systemic risks, through either concentration risks or a weakening of lending standards.[11]

The increasing role of technology can affect the above elements in some important ways, including through its influence on barriers to entry and its capacity to promote unbundling of product offerings. In many cases, financial innovations lower barriers to entry by reducing costs, enhancing economies of scale, and driving down transaction costs and information asymmetry.[12] Cloud computing in particular may allow firms to scale quickly (see sections 2.1.3 and 3.3, and annex 1), and provide smaller firms with capabilities previously reserved to firms with large capital budgets.[13] Thus, technological innovation may increase competition and promote market contestability. However, the access of market participants to technology might be uneven. Although traditional financial institutions have greater access to capital and

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8 For a recent analysis of such potential systemic risks, see FSB (2018), "Macro-financial vulnerabilities from operational risk: Scenario analysis and transmission mechanisms," March, SCAV/2018/10.

9 Open banking, as used in this report, refers to a system in which financial institutions' data can be shared for users and third-party developers through application programming interfaces (APIs). See section 2.2.

10 The report draws on some examples from specific private firms involved in FinTech. These examples are not exhaustive and do not constitute an endorsement by the FSB for any firm, product or service. Similarly, they do not imply any conclusion about the status of any product or service described under applicable law. Rather, such examples are included for purposes of illustration of new and emerging business models in the markets studied.

11 For studies on the link between bank competition and financial stability, see Thorsten Beck, Asli Demirguc-Kunt and Ross Levine (2006), "Bank Concentration, Competition, And Crises: First Results," Journal of Banking and Finance, 30(5): 1581-1603; Gabriel Jiménez, Jose A. Lopez, Jesús Saurina (2013), "How does competition affect bank risk-taking?" *Journal of Financial Stability*, 9(2): 185-195; and AHM Noman, CS Gee, and CR Isa (2017), "Does competition improve financial stability of the banking sector in ASEAN countries? An empirical analysis," PLoS ONE 12(5): e0176546.

12 The IMF provides examples of the ways that technology can promote increase of contestability: back-office automation allows firms to reduce fixed costs, automated credit scoring tackles information asymmetry, online payments help reduce transaction costs, peer-to-peer lending and crowd-sourcing raise efficiency of matching of savers and borrowers, see IMF (2017), Box 2. See also FSB (2017b), "Artificial intelligence and machine learning in financial services: market developments and financial stability implications," November, section 3.2.

13 US Treasury (2018), "A Financial System That Creates Economic Opportunities Nonbank Financials, Fintech, and Innovation," July, pp. 44-52.

usually allocate greater funds to adopt innovations, they may also be constrained by legacy IT systems, unlike newer FinTech firms. At the same time large, BigTech firms often possess both up-to-date technology and funds to apply the latest innovations, which may give them a competitive edge.[14]

Technology is facilitating the unbundling of many services that have traditionally been offered by banks and financial conglomerates. For example, FinTech credit and equity crowdfunding platforms provide alternative sources of finance to firms and consumers; electronic aggregators are gaining popularity as distributors of financial services; and robo-advisors can be beneficial for small investors. While technology will almost certainly reduce some barriers to entry, it is difficult to judge how material this will be.

The greater use of data, which are becoming critical in creating added-value in new services, may also have implications for market structure given its special characteristics. The value of data does not diminish by their use. The marginal utility of data might even increase as more are accumulated. These characteristics of data might accelerate concentration of data toward some data companies.

This report is organised as follows. Section 2 discusses drivers of changes in market structure due to FinTech, looking at technologies, regulation and demand factors. Section 3 assesses the current landscape, including market concentration of third-party providers, and provides case studies on FinTech credit and payments services. Section 4 gives an overall conclusion on financial stability and possible future steps by the FSB, the BCBS, and IOSCO.

2. Financial innovation and links to market structure

Earlier FIN papers have highlighted the drivers of FinTech innovations, including technology, regulation, and evolving consumer preferences, including customisation.[15] Here we focus on some specific drivers that could influence the market structure of the financial sector in key ways. On the supply side, these include the use of application programming interfaces (APIs) over the internet, cloud computing, and changes in consumer behaviour driven by smart phone technology. [16] The utility of certain technological applications has increased dramatically with big data and greater computing power.[17] Although it is too early to predict, going forward, applications of distributed ledger technology (DLT) may have significant impact.[18] Moreover,

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[14] Financial innovations are not being driven by FinTech firms and BigTech firms in all jurisdictions. For example, in Russia, banks occupy a leading position in adopting technological innovations. The most notable cases are Sberbank (leading online banking platform), Tinkoff bank (the first Russian online bank), and Alfa-bank (which has developed its own P2P platform).

[15] See FSB (2017a); CGFS and FSB (2017); and Basel Committee on Banking Supervision (BCBS) (2018), "Sound Practices: Implications of Fintech developments for banks and bank supervisors," February.

[16] Cloud computing is defined as 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. APIs are defined as a set of rules and specifications followed by software programmes to communicate with each other, and an interface between different software programmes that facilitates their interaction. See glossary.

[17] See FSB (2017), "Artificial intelligence and machine learning in financial services," November.

[18] Potential applications of DLT in financial services include innovations in payments and securities clearing and settlement, crypto-assets, trade finance, and mortgage loan applications, among others. These have been reviewed extensively in other

the pace of adoption of financial innovations has increased, meaning that market structure impacts could be felt more quickly than in past eras.[19] Some elements of financial regulation, such as licensing requirements and competition aspects in regulation, can also be relevant supply-side drivers as discussed below. Finally, there have been a number of changes in customer demand. This section considers each of these factors in turn.

2.1 Supply factors – technological developments

2.1.1 Use of APIs

The use of APIs allows different software applications to communicate with each other and exchange data directly, without the need for human inputs. APIs have been used for decades, for example, in the US to enable personal finance management software to present billing at bank websites, and to connect developers to payments networks.[20] They have become the de facto standard for sharing data, and recently became the mechanism of choice for use over the internet to enable organisations that hold large amounts of data to become platforms for third-party innovation.[21]

Newer deployments, including 'open APIs,' facilitate service improvements, particularly more immediacy in payments. It is reported that the programmable web, a public directory of web APIs, has grown the size of its records from just one in 2005 to more than 17,000 in 2017.[22] Several jurisdictions have or are developing frameworks for the application of APIs.[23] APIs can also support greater unbundling of services.[24] Yet the use of APIs, if not well deployed and securely managed, could in principle lead to new risks. In particular, poorly deployed API's could lead to increased market structure fragility.

2.1.2 Mobile banking and smart phones

With their greater functionality, mobile devices have become a key aspect of consumers' daily lives in many jurisdictions, significantly expanding the availability of services. Consumer expectations have risen with greater convenience of a range of services, including financial

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work, and are hence not summarised here. See FSB FIG report and CPMI (2017), "Distributed ledger technology in payment, clearing and settlement," February.

19 See BCBS (2018), p.13.

20 See Laura Brodsky and Liz Oakes (2017), "Data Sharing and Open Banking," McKinsey & Company.

21 See Open Data Institute & Fingleton Associates (2014), "Data Sharing and Open Data for Banks: A report for HM Treasury and Cabinet Office," September.

22 See HMT (2017), "Programmable Web API Directory Eclipses 17,000 as API Economy Continues Surge," March.

23 These include the European Union, the United Kingdom, Singapore, Japan, and Hong Kong. See HKMA (2018), "Consultation Paper on Open API Framework, for the Hong Kong Banking Sector," January.

24 See Joy Ogden (2016), "APIs Blurring the Competitive Advantage between Banking and Fintech," The Financial Brand. See also Mohit Mehrotra (2016), "The future of investment management: Open application programming interfaces," Deloitte: Performance Magazine Issue, p. 2 for the evolutionary path of APIs from 1960 to the present.

services.[25] Smart phones have become a platform for third-party developers to develop new products.[26] Combined with APIs, smart phones increasingly have payments capabilities built into their operating systems, thus capturing a 'client interface' through the purchase of a phone. For example, single platforms in China integrate online shopping, mobile phone wallet capability, and activities including money transfer between friends.[27] In other jurisdictions, the mobile payments market is more disaggregated.

2.1.3 Cloud computing

Cloud computing refers to the practice of using a network of remote servers, typically accessed over the internet, for the provision of IT services.[28] Cloud computing offers advantages such as economies of scale, flexibility, operational efficiencies and cost effectiveness. Some of the types of services and methods of deployment are illustrated in annex 1.

Presently, financial institutions mainly use the cloud for such operations as customer relationship management, human resources, and financial accounting. However, PWC predicts that by 2020 institutions will also run such services as consumer payments, credit scoring, statements and billings for asset managers' basic current account functions on the cloud.[29] Gartner projects total global spending by financial institutions on public cloud services to grow from $37 billion in 2017 to $55 billion in 2020.[30]

Outsourcing arrangements relying on cloud services are typically subject to regulatory standards and frameworks.[31] Also, cloud computing services can be integral to an entity's ability to fully use APIs, including for building, deploying and monitoring APIs to assess them against key business indicators.[32] Authorities, including financial services authorities and self-regulatory entities are also using cloud computing and related services in some cases.[33]

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[25] See Marianne Crowe, Elisa Tavilla, and Breffini McGuire (2017), "Mobile Banking and Payment Practices of U.S. Financial Institutions: 2016 Mobile Financial Services Survey Results from financial institutions in Seven Federal Reserve Districts," Federal Reserve Bank of Boston, December, p. 14.

[26] See Lael Brainard (2017), "Where Do Banks Fit in the Fintech Stack," speech at the Northwestern Kellog Public-Private Interface Conference on "New Developments in Consumer Finance: Research and Practice," 28 April.

[27] See Wei Wang and David Dollar (2018), "What's happening with China's fintech industry," Brookings.

[28] See BCBS (2018), Graph 9: Range of usage of cloud-based services. Source: Technet.

[29] PWC (2016), "Financial Services Technology 2020 and Beyond: Embracing Disruption."

[30] Fred Ng and Rajesh Kandaswamy (2017), "Market Insight: Value-Based Cloud Opportunities in Financial Services," Gartner, April.

[31] See, e.g., Mark Zelmer (2012), "New technology-based outsourcing arrangements," Canada OSFI; European Banking Association (2017), "Final Report: Recommendations on outsourcing to cloud service providers," December; Monetary Authority of Singapore, (2016), "Guidelines on Outsourcing," July; US Office of the Comptroller of the Currency (2017), "Frequently Asked Questions ("FAQs") supplementing the OCC's 2013 Bulletin," June; Adam Chernichaw and Daren Orzechowski (2012) "FFIEC Statement on Outsourced Cloud Computing," White & Case Technology Newsflash; UK FCA (2016), "FG16/5 – Guidance for firms outsourcing to the 'cloud' and other third-party IT services," July.

[32] See Oracle (2017), "PSD2 with Oracle API Platform Cloud Service: Oracle Solution Brief," August.

[33] Regarding public authorities use of the cloud, see e.g. US Securities and Exchange Commission (SEC) (2017), "Annual Financial Report," November, p. 53 on use of cloud computing; and Commodity Futures Trading Commission (CFTC) (2014), "2014-2018 Information Technology Strategic Plan," December, pp. 43-45 on plans to move activities to private cloud. Among self-regulatory organisations, see John Brady (2017), "FINRA's use of cloud services," presentation to 2017

2.2 Supply factors – regulation

Since the global financial crisis, the G20 regulatory reforms have made the global financial system materially more resilient.[34] In addition to the G20 reforms, a number of other policy interventions may impact on the development of FinTech firms, BigTech firms and incumbents. This section provides a few examples.

2.2.1 Licensing and supervision regulation

Changes in licensing and prudential supervision frameworks can impact the emergence of new FinTech business models. As noted in the recent BCBS report, most current supervisory and licensing frameworks predate the emergence of FinTech.[35] That report recommends to supervisors, where appropriate, to monitor the impact of new business models and financial services delivery systems to determine how they affect their ability to supervise end-to-end financial transactions. BCBS surveys indicate that authorities are comfortable with the applicability of regulatory requirements to banking services provided by FinTech firms and nearly half the regulatory authorities surveyed also are considering new regulations or guidance related to emerging FinTech services.

2.2.2 Competition aspects in financial regulation

After the financial crisis, new models emerged with respect to the role of competition and the financial services sector. For example, in 2015 the UK Financial Conduct Authority gained concurrent powers for enforcement of competition policy. Supervisors in other jurisdictions have also been granted competition-related powers, or introduced new methods of cooperation with competition authorities. In many cases, ensuring contestability and a level playing field is an explicit policy objective, and some authors have suggested assessing the application of antitrust tools, such as merger controls, alongside regulation to ensure financial stability.[36]

A particularly salient example of regulation aimed at promoting competition is in policies around open banking. In the European Union, this was decided in 2015 through the revised Payment Services Directive (PSD2). PSD2 intends to make it easier and safer to use internet payment services; better protect customers against fraud, abuse and payment problems; and promote innovative mobile and payment services.[37] PSD2 mandates open access to certain

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FINRA Annual Conference, regarding the use of cloud services to capture, analyse and store records. Among FMIs, see Depository Trust Corporation (2017), "Moving Financial Market Infrastructure to the Cloud: Realizing the Risk Reduction and Cost, Efficiency Vision While Achieving Public Policy Goals," White Paper, May.

[34] FSB (2018), "Implementation and Effects of the G20 Financial Regulatory Reforms: Fourth Annual Report," November.

[35] BCBS (2018).

[36] See Elena Carletti and Agnieszka Smolenska (2017), "10 years on from the Financial Crisis: Co-operation between Competition Agencies and Regulators in the Financial Sector," Note for OECD Working Party No. 2 on Competition and Regulation.

[37] Compliance with specific technical standards is not required until mid-2019.

types of customers' banking data[38] for non-bank licensed providers of payment initiation services (PIS) and account information services (AIS). The latter providers are thus allowed to acquire information pertaining to personal online banking accounts, if customers explicitly so choose, and banks are not entitled to deny their access right. Under PSD2, customers should be able to open one app for one account and see a list of all their accounts, even those with other banks; authorise licensed third parties to access a certain set of their payment-related banking details without having to provide login details; and decide which information they want to share with what provider and for how long.[39] Similarly, the EU interchange fees regulation (IFR), which entered into force in 2015, aims to enhance competition by reducing interchange fee flows for card based payments and increasing transparency in this market sector.[40] In other jurisdictions, comparable developments include 2017 revisions to the Banking Act in Japan, which included provisions to encourage banks to open their APIs, as well as banks' ability to acquire FinTech firms and/or collaborate with them to promote innovation and efficiencies. The Canadian competition authorities in 2017 also completed a similar review of the payments sector (along with a review of lending and equity crowdfunding, and investment dealing and advice).[41] The recently passed Mexican FinTech Law (approved on 1 March 2018) also includes requirements for financial entities, including FinTech firms, and novel models (such as a regulatory sandbox) to open data through APIs to third parties and allows them to collect fees for this; to prevent these fees from being excessive or incongruent, financial authorities will authorise the proposed fees and can veto them. In Australia, the government has announced that a 'consumer data right' (giving customers a right to direct that their data be shared with others they trust) will be applied sector by sector, with open banking to be the first application.

2.2.3 Other areas of regulation

In addition to these areas, the regulatory approaches to the oversight of cloud service providers may be relevant (see annex 1). In some cases, these approaches have considered concentration risks and cloud services.

Moreover, data protection regimes can have an impact on both the degree of competition and contestability of markets (i.e. the ability of new players to enter), and the potential for firms to expand internationally. Specifically, the cross-border application of different regimes may hinder global business operations. As one commentator noted, "fragmentation and market barriers are emerging around requirements for privacy and data flows across borders that make international operability a growing challenge."[42] Moreover, there may be a risk that firms located in jurisdictions with restrictive data protection regimes are not permitted to operate in third countries on the grounds of the firms' inability to subject themselves to effective

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[38] I.e. designated payment account-related data (and associated payment transactions) provided the former type of account is available on-line.

[39] See European Commission (2016), "European Parliament adopts European Commission proposal to create safer and more innovative European payments," October.

[40] Regulation (EU) 2015/751 of the European Parliament and of the Council of 29 April 2015 on interchange fees for card-based payment transactions.

[41] See Competition Bureau of Canada (2017), "Technology Led Innovation in the Canadian Financial Services Sector," December.

[42] See Sacks (2018).

supervision from third-country regulators. Another financial stability concern raised by data protection regimes is that third-country authorities' ability to supervise foreign firms from operating in their jurisdiction (either directly or in cooperation with a foreign regulator) may be hindered. This would be mitigated if data protection frameworks offer a mechanism that ensures that third-country authorities have access to the personal data needed to conduct their supervisory and enforcement activities.

2.3 Demand factors – changing customer expectations

In the retail environment, the digitisation of commerce has meant that customers expect more convenient experiences across the services that they use. These expectations are likely to continue to rise as different delivery systems, such as voice-activated devices, evolve.[43] Real-time transacting capability of internet-connected devices has given rise to higher customer expectations with regard to convenience, speed, cost and user-friendliness of financial services. Consumer comfort with online financial transactions has also grown as online business innovations have deepened this rising acceptance of new technologies.

There are also demographic factors driving demand, such as the growing financial influence of the cohorts known as digital natives and millennials. These younger cohorts may be more likely to adopt FinTech.[44] In particular, these consumers may have greater trust in the services of lending market entrants.[45] There may be a more general perception among some consumers that FinTech credit, and especially peer-to-peer (P2P) lending, which directly matches lenders and borrowers, is more socially responsible and of greater social value than conventional banking.[46]

Finally, there are also economic development and convergence factors, such as the rapid adoption of digital technology in some emerging market and developing economies. In several large economies, particularly in Asia, the growing supply of wealth and a desire for higher returns in the face of low yields has provided FinTech platforms with a larger investor base. This may also drive higher demand from institutional investors. Investors may regard FinTech loans as an alternative asset class that can add to diversification of their portfolios. The convenience of investing through online and mobile tools may also be an important driver.

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[43] Some financial institutions offer virtual assistance on Alexa, Amazon's artificial intelligence powered voice interactive device. See Jingnan Ho (2017), "EU's new data privacy law creates headaches for U.S. banks," American Banker, September.

[44] See EY (2017), "EY FinTech Adoption Index 2017," July.

[45] For instance, a 2018 survey of 152,000 consumers in 29 countries, conducted by Bain & Company, found that 54% of respondents would trust at least one technology company with their money more than banks, with a higher share among younger cohorts. See Gerard du Toit, Katrina Bradley, Stanford Swinton, Maureen Burns, Christy de Gooyer, and David Phillips (2018), "In Search of Customers Who Love Their Bank," Bain & Company, November. Similarly, a 2015 Gallup poll showed that a larger share of Americans have a positive opinion of technology companies than of banks. See Niall McCarthy (2015), "Americans Trust Tech Firms More Than Banks for Finance," Forbes, June.

[46] See Alistair Milne and Paul Parboteeah (2016), "The Business Models and Economics of Peer-to-Peer Lending," European Credit Research Institute, May.

3. The current landscape

This section assesses the impact that these drivers are having on the provision of financial services. It selects specific areas that are illustrative of the broader trend, and upon which data from members and public sources are available. Specifically, it assesses: (i) the impact to date of FinTech firms, including the impact of FinTech credit on lending markets; (ii) the impact to date of BigTech firms, including payment services in the US and China; and (iii) the third-party service providers, including in the global markets for cloud computing and data services.

3.1 Impact to date of FinTech firms

Various FinTech services are being used by substantial shares of retail clients in specific markets, particularly in China.[47] Yet to date, FinTech firms have typically found new niches – e.g. platforms for P2P lending, crowdfunding, and cross-border payments – and underserved clients,[48] such as small businesses or people who lack a credit history. In other cases, they have cooperated with incumbents or BigTech firms.[49] Cooperation gives FinTech start-ups access to clients (for example, through selling white-label and co-branded products) while, depending on the jurisdiction and the business model, potentially reducing their regulatory compliance burden. In turn, incumbents get access to innovative technologies and products and can gain advantage by being the first ones to offer their clients new products and services.

One area that may see more competitive pressure from FinTech is lending, particularly to underserved segments of the population. As described in previous FIN work, a range of new lending platforms, including P2P and marketplace lenders, have appeared in jurisdictions around the world.[50] These platforms often have access to online methods of client interaction; new data sources and methodologies for analysing data (such as machine learning); and new business models. In theory, this can create competitive pressure for incumbents, and force them to streamline their own loan underwriting processes and employ better and faster data analytics systems. So far, competitive pressures on incumbent lenders in most established market segments appear limited. Available data suggest that despite rapid growth, FinTech credit is still small as a proportion of overall credit in most jurisdictions, including China, Korea, and the UK (see annex 2). Credit quality of P2P lending platforms has also been a concern.

On the other hand, cooperation between incumbents and FinTech firms has been observed in a number of markets. Often, incumbents outsource to FinTech firms some of their lending business,[51] while FinTech firms benefit from access to incumbents' client base and reputation.

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47 EY (2017), "EY FinTech Adoption Index 2017," July. EY estimate that 33% of the surveyed population in jurisdictions around the world are regular users of FinTech services, with 69% in China, 54% in India and 42% in the UK.

48 This is especially relevant for the jurisdictions with less developed financial markets, where the underserved may get access to financial services through smart devices such as mobile phones.

49 According to Accenture, in 2015 38% of global investment went to FinTech companies hoping to collaborate with financial institutions compared to 62% of investment into FinTech firms looking to compete against the financial services industry. In North America the proportion was 60 to 40% respectively. See Robert Gach and Maria Gotsch (2016), "Fintech's Golden Age," Accenture.

50 CGFS and FSB (2017); Stijn Claessens, Jon Frost, Grant Turner, and Feng Zhu (2018), "Fintech credit markets around the world: size, drivers and policy issues", BIS Quarterly Review, September.

51 R. Jesse McWaters and Rob Galaski (2017), "Beyond Fintech: A Pragmatic Assessment of Disruptive Potential In Financial Services," World Economic Forum, August.

Lending platforms have also entered segments where they have no competition from the incumbents, e.g. among unbanked clients (providing online services to those who cannot apply for loans from traditional players) and underserved segments (small businesses, subprime customers, and clients with insufficient credit history or lower job security). Partnerships are also common in the payments space.

3.2 Impact of BigTech firms

In some jurisdictions, large, well-established technology firms have recently entered financial services markets. These firms can provide financial services as part of the products or services that they normally provide. BigTech firms can partner with incumbents and act as distributors of their payment, lending and insurance products (which is being significantly simplified through APIs). Alternatively, their access to a large quantity of client data could allow them to carry out risk assessments, which could underpin the provision of credit.

Table 2 provides an overview of financial activities currently provided by BigTech firms. The Chinese BigTech firms (Alibaba, Baidu and Tencent) in particular are active across a range of financial services. In many cases, these firms partner with incumbent financial institutions or new FinTech players to offer credit, insurance, wealth management services over their platforms. In the United States, Amazon lending, launched in 2011, offers loans to merchants selling goods through its marketplace. As of December 2017, Amazon had $2.6 billion in seller receivables related to its seller lending programme.[52] Recently, Amazon has begun a partnership with Bank of America on small business lending, and is reportedly in talks with banks around a checking account product.[53] In Australia, Japan, and the UK, PayPal Working Capital is also increasing lending to businesses. In East Africa, Egypt and India, Vodafone M-Pesa reports having 32 million active users in payments, and in Kenya offers credit and deposits products through M-Shwari.[54] In Latin America, e-commerce platform Mercado Libre had lent $127 million in various markets as of late 2017, and is experimenting with asset management and insurance products.[55]

A traditional commercial bank's business model relies heavily on establishing a large number of preferably stable customer relationships; at its simplest, allowing it to raise deposits from customers with a liquidity surplus and grant loans to businesses and consumers with funding needs.[56] In this intermediation process, the bank earns revenues: (i) from the net interest margins and fees on the intermediation process, and (ii) from cross-selling (through the long-

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[52] See Amazon (2018), "Annual Report 2017," February, p. 46. See also CBInsights (2018), "Everything You Need To Know About What Amazon Is Doing In Financial Services," September.

[53] Reuters (2018), "Amazon mulling checking-account like product with big banks: WSJ," 5 March.[54] See Vodafone Group Plc (2018), "Annual Report 2018," June, p. 28. [55] Mercado Libre (2018), "Sustainability Report 2017," May.

[54] See Vodafone Group Plc (2018), "Annual Report 2018," June, p. 28. [55] Mercado Libre (2018), "Sustainability Report 2017," May.

[55] Mercado Libre (2018), "Sustainability Report 2017," May.

[56] Investment banks' business models are more focused on trading activities (proprietary or on clients' behalf), investment packaging and issuances for corporate clients (e.g. structured products) and advising (e.g. M&A) and therefore rely less on a large and stable customer base.

term relationship) of other financial services and products (e.g. payments, savings, insurance, wealth management) where fee and other income may be earned.

Table 2: Selected financial activities of BigTech firms

	Alibaba	Tencent	Baidu	Google	Amazon	Facebook	Apple	Samsung	Microsoft	Vodafone	Mercado Libre
Payments	AliPay (largest mobile paymensts platform in China)	Tenpay (#2 mobile payments platform in China)	Baidu Wallet – cooperation with PayPal	Google Pay – layers over existing card network	Amazon Pay – layers over existing card network	Messenger Pay – layers over existing card network	Apple Pay – layers over existing card network	Samsung Pay – layers over existing card network	Microsoft Pay – layers over existing card network	M-Pesa (32 million active users in East Africa and India)	Mercado Pago (offered in 8 markets in Latin America)
Lending and short-term credit	MYBank (SME lending for rural areas and online merchants)	WeBank (Personal micro-loans)	Baixin Bank (financial products and small loans)	Collaboration with Lending Club	Temporary financing in Amazon Lending; direct lending to merchants	Pilot in collaboration with Clearbanc	n/a	n/a	n/a	Offered through M-Shwari mobile banking service	Mercado Crédito (small loans to retail and SME clients)
Current accounts	Offered through MYBank	Offered through WeBank	Offered through Baixin Bank	n/a	Reports of talks with banks	n/a	n/a	n/a	n/a	Offered through M-Shwari	n/a
Asset management	Yu'e Bao (world's largest MMF)	License to offer mutual funds	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Pilots ongoing in 2018
Insurance	60% stake in Cathay Insurance China, founding stake in Zhong An Insurance	Online insurance service in life and property insurance	Joint venture with Allianz, and Hillhouse Capital announced	Insurance on Google Compare (discontinued)	Partnership with JPMorgan Chase and Berkshire Hathaway on health insurance	n/a	Cooperation with Allianz or cyber insurance discounts	n/a	n/a	n/a	Pilots ongoing in 2018

With their access to client data, BigTech firms may be able to acquire market share in the second area, in particular, which is often a high-revenue part of banking activities. There has for instance been some expansion into mobile payments, though, at present, they have largely been overlays onto existing payments infrastructure. Yet even in its current form, this can have an effect on existing institutions both by levying fees on institutions for access to the technology, and by altering the customer relationship. For the Chinese BigTech firms and M-Pesa, there is a separate payments infrastructure.

Similarly, in the insurance industry, technology is already changing the distribution of products and the interactions with customers. BigTech firms are able to provide services quickly, in a convenient way, 24 hours a day and without the need to contact an insurance broker. Customer experience is additionally improved through the use of such amenities as game-like interfaces ('gamification'), the internet of things (IoT), usage-based insurance, robo-advisors and so on.

While BigTech firms that provide financial services could be thought of as a subset of FinTech, they differ from other FinTech firms in some key regards. First, BigTech firms often already have established networks and a very large customer base. Because of their size, BigTech firms are usually well capitalised and do not face the same constraints accessing external funding as FinTech firms. Secondly, technology companies may be able to use proprietary customer data from their non-financial-service operations, providing a competitive advantage in the provision of financial services. Third, BigTech firms may have ready access to the forefront technologies to process big data, including cloud computing, artificial intelligence and machine learning. Thus, they may enjoy some competitive advantages over financial services firms.

Box 1: The Case of Ant Financial

An illustration of how fast a technology firm can enter finance is given by Alibaba and its subsidiary Ant Financial, which were created respectively in 1999 and 2014. Based on the data from its e-commerce business, and its mobile payments platform (Alipay), Ant Financial has extended its product range into wealth management, with Yu'e Bao, now the world's largest money market fund (MMF) (see annex 3); credit scoring, through Sesame scores of firms and individuals; and credit provision, with five million loans granted to small and medium enterprises (SMEs) in the first three years of operation.[57] Ant Financial is also a major distributor of insurance products, including through a majority stake in Cathay Insurance China and a founding stake in ZhongAn insurance,[58] China's first online-only insurance company, with 535 million insured customers and 7.5 billion policies. Similarly, Tencent, the operator of WeChat and Tenpay, is also a significant player in many of these industries, and holds a 30% stake in online bank WeBank. Baidu, the country's largest search engine, has also branched into banking and financial products. Annex 4 discusses the rapid increase in concentration in the Chinese mobile payments market, where Alipay and Tenpay accounted for 94% of the total market. While rapid growth in mobile payments is being observed in some markets in Southeast and South Asia, in other jurisdictions, there is less evidence that BigTech firms could replicate

[57] See CBInsights (2018), "Ant Financial: Unpacking the $150 billion fintech giant," September.

[58] Ant Financial owns 16% of the company. Ping An and Tencent hold respectively 12%.

the Ant Financial model and no evidence to date that they are seeking to compete with incumbents in such a wide range of sectors.

3.3 Third-party service providers (e.g. cloud computing and financial market data)

For decades, financial institutions have relied on localised 'on-site' computing service solutions provided by a limited number of technology firms. Presently, the level of reliance of financial firms on cloud computing providers for storage of core financial data may be low. The European Union Agency for Network and Information Security (ENISA) reported in 2015, for example, that while 88% of European financial institutions used at least one cloud application, only 1% were running 'core' applications.[59] In Asia-Pacific, similar trends are found.[60] Similarly, available evidence suggests that global insurance companies are using cloud services primarily for business support functions, but that increasingly, some insurers are using cloud infrastructure to support core functions.[61]

The rate of adoption of outsourced cloud computing by regulated financial institutions has been limited by several factors, including a lack of understanding of the technology itself. While there is anecdotal evidence that this is changing, data on these trends within and across jurisdictions are scarce.

Although the four leading cloud service providers account for almost 60% of the global market for total cloud computing,[62] and provide a wide range of different cloud services, financial institutions typically adopt a combination of cloud services across a vast and growing number of vendors depending on business needs and scalability considerations (as described in Section 3.4). Financial institutions are estimated at 15% of global spending on public cloud services (annex 1). Survey data on the market share of providers to a sample of financial institutions are available from some providers.

In the market for financial market data and analysis for financial institutions, estimated at $27 billion annually, two institutions are estimated to control more than half of the market.[63] The market shares in this industry have been broadly constant in the past eight years and have not been linked to financial stability risks. Regulatory change and a drive to outsource key data functions have increased the overall size of the market.

3.4 How firms utilise cloud computing

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59 ENISA (2015), "Secure Use of Cloud Computing in the Finance Sector: Good practices and recommendations," December.

60 Asia Cloud Computing Association (ACCA) (2018), "Asia's Financial Services on the Cloud 2018: Regulatory Landscape Impacting the Use of Cloud by FSIs," April.

61 Juan Carlos Crisanto, Conor Donaldson, Denise Garcia Ocampo and Jermy Prenio (2018), "Regulating and supervising the clouds: emerging prudential approaches for insurance companies," FSI Insight, December.

62 The four leading cloud service providers account for almost 60% of the global market for total cloud computing. See Synergy Research Group (October 2017).

63 Burton-Taylor (2017), "Financial Market Data/Analysis: Global Share & Segment Sizing 2017," accessed 1 March 2018.

Today, the growing adoption of FinTech innovations has diversified the way in which computing resources are delivered and how technology is used by firms. Cloud computing is not a new technology, but rather a new way of delivering computing resources (i.e., from data storage and processing to software such as email handling). Nonetheless, it has the potential to significantly improve the security and resilience of financial institutions.

With the ability to choose how to deploy, firms can opt to build a private cloud, move across clouds by applying "containerisation"[64] architecture, or use multiple cloud service providers for a variety of cloud-based services. Firms may also implement a hybrid approach, in which a fraction of computing services come from internal data centres with private on-site cloud architecture that can be scaled for critical computing needs to minimise risk, while operating in utility mode across multiple cloud vendors. Such approaches can help not only to avoid vendor capture and result in the provision of more affordable cloud services for a large number of financial firms, but can also provide financial firms with features and services that promote greater security and have higher degrees of operational resilience when compared to traditional practices. Moreover, cloud services may enable much smaller financial institutions access to far more sophisticated architecture and security features than they would be able to acquire on their own. Similar benefits may extend to start-ups, and to financial institutions in emerging market and developing economies.

4. Conclusions on financial stability and implications

This paper has sought to examine three quite different FinTech related developments that are altering, or have the potential to alter, the current structure of the financial system and as a result may have implications for financial stability. These developments are: (i) new providers of bank-like services competing or cooperating with established financial services providers; (ii) provision of financial services by large technology companies; and (iii) reliance on third-party providers for cloud services. For each, it has considered evidence of changes in market structure to date and potential scenarios in the future.

4.1 Summary of findings

For the purposes of considering financial stability implications, (i) and (ii) above are closely related. Clearly many FinTech firms offer products that potentially challenge the traditional business models of financial institutions. However this may play out in a number of different ways, which will have different implications for financial stability.

i. They may partner (or be taken over) by financial institutions, allowing the financial institutions to improve their service level or efficiency.

ii. They may provide a service which is complementary to those provided by existing financial institutions. This could improve the attractiveness of the existing service, e.g. payments 'front-ends' that utilise existing networks and maintain (or increase)

[64] This process entails deployment that helps firms easily "shift-and-lift" utility central processing unit (CPU) workloads from one provider to another given that can virtualise and containerise their CPU workloads in smaller containers ready to move from one vendor to another should they need to do so.

existing transaction flows. Or, for instance by using open banking services, they may facilitate stronger competition between financial institutions by increasing transparency or making the switching of providers easier. While these services may complement those offered by a financial institution, they may have some detrimental effects on the financial institution, by replacing or weakening the institution's traditional customer relationship.

iii. They may compete directly with existing financial institutions, reducing margins in the affected segments and reducing the financial institution's capacity to cross-subsidise products.

The entry of BigTech firms could expedite or amplify these effects through these firms' existing wide customer base, trusted customer relationships, strong capital positions and easy access to external funding, and potentially different business focus (for instance to exploit data rather than rely directly on fees). Therefore, while the financial stability implications of FinTech have generally been judged to be small because of their relatively small size, this could change quickly with deeper involvement of the large technology providers. It is also possible that the fairly rapid move to open banking around the world could change the competitive dynamics in financial services.

Increased reliance, from a low base, on third-party providers for cloud computing is somewhat distinct, even though some of the same technology companies might be involved. This development offers commercial benefits to banks, rather than market competition. There appear likely to be strong commercial pressures for banks to engage increasingly with these services, though potentially constrained by banks' own risk management or supervisory restrictions.

The benefits derived from the above developments are closely aligned with those from FinTech generally – more efficient, convenient and lower-cost delivery of financial services.[65] These benefits derive not just from the innovations themselves, but through the heightened competition they bring. In particular, FinTech firms may compete more effectively in narrow product areas and by doing so be able to break down some of the bundling and cross-subsidisation practiced by banks. Changes in how customers interface with financial services providers might also reduce some of the stickiness of existing customer relationships, again improving competition, although there is a possibility that this is replaced by stickiness in other relationships. There may be greater decentralisation and diversification of financial services, and improved access to data may lead to better credit assessments. At the margin these developments may represent an enhancement of financial stability through, all else equal, wider access to financial services, more efficient pricing and better allocation of credit. The potential macro-financial risks from these developments relate to the effects of competition and disruption of business models on profitability, and therefore the ability to accumulate capital through retained earnings. This largely arises where FinTech firms actively compete with the incumbents or where their actions increase the mobility of customers. This could ultimately

[65] Some firm-specific benefits may result from differences in regulation of FinTech firms and BigTech firms in comparison to incumbents. These advantages may not be of permanent nature but diminish if regulation becomes more specific.

lead to an inappropriate loosening of lending standards by banks, and more risk-taking by other financial institutions.

While there may be micro-financial risks from cyber incidents, technology such as cloud computing may enhance operational and cyber resilience and mitigate these risks. Moreover, BigTech firms may provide various free services because of their ability to use the data for other business lines. Customers provide personal data in exchange for using these services, instead of paying fees. In addition, to the extent that activities are not regulated, governance of financial risks in particular may be less well developed than with regulated institutions. New players and relationships may also give rise to heightened legal risk.

4.2 Implications

While the three developments addressed by this paper do not currently pose risks in most jurisdictions, they may nonetheless warrant vigilance by supervisors. This may include monitoring the impact of heightened competition on profitability and lending standards, as well as increasing cyber risk. None of this is new; banks have had competitive pressure from many sources in the past and have long faced operational risks. The developments discussed in this paper however suggest that these issues may become more acute for three reasons:

(i) The raft of new technologies introduced in the past few years, and the impetus provided by open banking could also change the dynamics of competition quickly.

(ii) Changes in business models may occur more quickly than in the past as BigTech companies actively and successfully push into traditional financial services.

(iii) The technology focus of both new providers and incumbents – particularly where they are closely integrated into firms' operations – may entail a new dimension of operational risks.

More generally, as discussed in earlier FSB reports, there is the potential for new, large players to provide financial services from outside the traditional financial sector. Authorities may wish to regularly assess stability risks, bearing in mind the comparability of the functions performed, the level and types of risks involved, and the size of those activities.[66] The incentives and barriers to entry by BigTech firms into the financial services space are not yet well understood. The scale of BigTech activities in finance varies considerably across jurisdictions. Understanding these firms' motives is key to assessing whether this trend could change in the future.

Traditional third-party service provider arrangements may present challenges in the future. Financial institutions that do not currently rely on cloud computing service providers for their core business operations still employ traditional computing services, but this could change in the future. Laws, regulations, and supervisors' policies and guidance on outsourcing are intended to ensure that financial institutions properly manage the risks associated with outsourcing, including by ensuring that controls over outsourced service providers are

[66] FSB (2017a); FSB (2017b).

maintained to the same standard as those over the bank's own operations. Some jurisdictions are considering ways to ensure the required very high levels of resilience. The BCBS notes that, although most supervisors have some reach over third-party providers – either directly or through contractual arrangements – the majority of supervisors indicate that they supervise third party providers only in limited cases and have no formal structures in place to do so regularly.[67] Particular attention is being devoted to third-party dependencies issue, including by the BCBS and IOSCO.[68]

Going forward, the FSB Financial Innovation Network (FIN) is, in cooperation with other groups, further exploring third-party dependencies in cloud services and single point of failure risks. Specifically, the FIN is seeking to better understand the market for cloud services for financial institutions (rather than for all clients), including how they manage lock-in risk and cross-border issues. Moreover, it is monitoring the activities of BigTech in finance, including cross-border activities. The FIN will continue to report its findings to SCAV.

[67] BCBS (2018), pp. 36-37

[68] IOSCO is engaged in cross-committee work on outsourcing and third-party service providers in relation to trading venues, intermediaries, post-trade services in derivatives, credit rating agencies and cloud computing. The BCBS Financial Technology Network continues to discuss issues raised in BCBS (2018).

Glossary

This glossary defines terminology used in this report. Where available, definitions are aligned with previous reports of the FSB, the Basel Committee on Banking Supervision (BCBS), BIS Committee on the Global Financial System (CGFS), Committee on Payments and Market Infrastructures (CPMI), Financial Action Task Force (FATF), BIS Markets Committee (MC), International Organization of Securities Commissions (IOSCO), as summarised in the glossary of the Economic Consultative Committee (ECC) ad hoc group on digital innovation.

- **Application programming interface (API):** a set of rules and specifications followed by software programmes to communicate with each other, and an interface between different software programmes that facilitates their interaction.
- **BigTech** or **BigTech firms:** large technology companies that expand into the direct provision of financial services or of products very similar to financial products.
- **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.
- **Composition:** the characteristics of participants in a market, such as sellers and buyers, intermediaries, and regulators.
- **Concentration:** the degree to which an industry's total output is produced by a small number of firms.
- **Contestability:** the possibility for new companies to enter a market and create competition to the incumbents.
- **Distributed ledger technology:** a means of saving information through a distributed ledger, i.e. a repeated digital copy of data at multiple locations, as in blockchain.
- **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.
- **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.
- **Market structure:** the interrelation of companies in a market that impacts their behaviour.
- **Open banking:** a system in which financial institutions' data can be shared for users and third-party developers through APIs.
- **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.

Annex 1: The use of cloud computing by financial institutions

The initial take-up of cloud computing in financial institutions was slower than in other sectors due to transition costs, security concerns and the complexities of regulatory compliance. For example, to move the same software to a different infrastructure, applications moved to the cloud must be redesigned to be fault tolerant and secure in a new environment, and contractual responsibilities must be parsed out between institutions such as banks and the cloud service provider. Both FinTech and BigTech firms increasingly rely on cloud computing to conduct business and compete. FinTech and BigTech firms may benefit from designing systems on the cloud from the beginning, rather than having to revamp legacy IT systems. The types of services and methods of deployment are illustrated in tables 1 and 2.

Table 1: Cloud service models

Infrastructure as a Service (IaaS)	Platform as a Service (PaaS)	Software as a Service (SaaS)	Business Process as a Service (BPaaS)	Data as a Service (DaaS)
Supplies customers with IT infrastructure, provided and managed over the internet on a pay as you use basis e.g. servers and storage	Supplies customers with an on-demand environment for developing, testing, delivering and managing software applications over the internet	Allows customers to connect to and use cloud-based apps over the Internet on a subscription basis e.g. Microsoft office 365	Automated business process delivered from a cloud service. BPaaS usually has a well-defined interface which makes it easy to be used by different enterprises	Uniting of the data and the software needed for its interpretation into a single consumer product made available to customers over a network, typically the Internet

Table 2: Cloud deployment models

Public Cloud	Private Cloud	Community Cloud	Hybrid Cloud
Operated and owned by a third-party cloud service provider, which delivers computing resources over the internet	Cloud computing resources that are used solely by one single organisation. Can be located physically on the company's onsite data centre or externally via a third party service provider	A community cloud is accessible to the members of a larger community comprised of different organisations or groups, and where partner organisations and the cloud provider co-manage everything from operations to facilities	Combines public and private clouds with technology that allows data and applications to be shared between them

Source: Abhinav Garg (2017), "Cloud Computing for the Financial Services Industry," Sapient Global Markets.

Deloitte estimates that global IT spending on data centres, software and IT services across all sectors will grow from $1,406 billion in 2016 to $1,552 billion in 2018,[69] and that IT-as-a-

[69] Deloitte (2017), "2017 Technology, Media and Telecommunications Predictions."

service will capture a much larger share of the overall market (rising from $361 billion to $547 billion over the same period). At this pace, it is estimated that IaaS will represent more than half of IT spending by 2021. Gartner estimates that, across all industries, global public cloud services markets grew by 21% in 2018 to $176 billion, while spending by financial institutions on public cloud services grew at a similar rate to $37 billion (15% of the total market).[70]

The advent of cloud computing for outsourcing has prompted updating of regulatory guidance on outsourcing, with regulators mindful of and taking into account the concentrated cloud service markets. Lock-in risk is always a challenge in outsourcing to third party services, including cloud, and can be mitigated through effective approaches to outsourcing. The European Banking Authority (EBA) has noted: "[cloud service providers] raise challenges in… concentration risk, not only from the point of view of individual institutions but also at industry level, as large suppliers of cloud services can become a single point of failure when many institutions rely on them."[71] It is an open question whether cloud services materially change such risks as compared to existing data centres and services.

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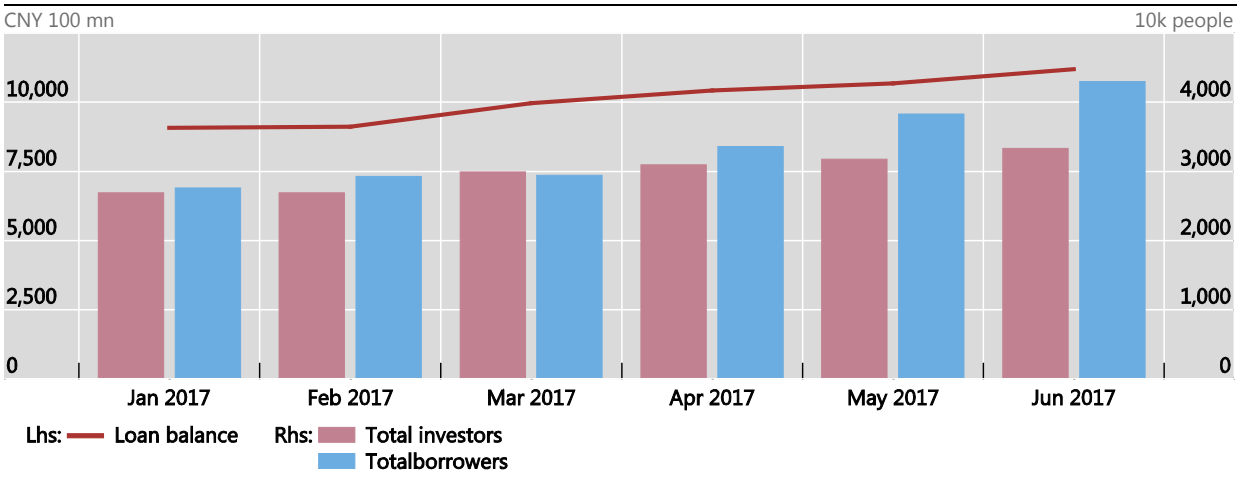
[70] Gartner (2018), "Gartner Forecasts Worldwide Public Cloud Revenue to Grow 17.3 Percent in 2019," September.

[71] See EBA (2017), "Final Report: Recommendations on outsourcing to cloud service providers," December, p. 5.

Annex 2: FinTech credit in China, Korea, and the UK

Available data suggest that despite rapid growth, FinTech credit is still small as a proportion of overall credit in most jurisdictions.[72] In China, which is the largest market for FinTech credit in absolute terms, there were 2,525 FinTech credit platforms at the end of June 2017. (This was 132 less than at the end of March, as some platforms ceased operations and the growth of suspicious platforms slowed down.) Meanwhile, FinTech credit volumes have steadily grown. In the first half of 2017, cumulative lending reached RMB 1.359 trillion ($215 billion), and the balance of outstanding loans was RMB 1.119 trillion ($177 billion), an 11% increase over end-March (figure 1). This was roughly 3% of overall outstanding household credit in China. The average rate of return for investors rose to 9.0%, with the maturity of lending decreasing to 9.5 months. Cumulatively, the industry had 76.23 million participants (investors and borrowers), or about 5.5% of the Chinese population.

Loan balance and number of participants of online credit industry in China — Figure 1



Source: People's Bank of China

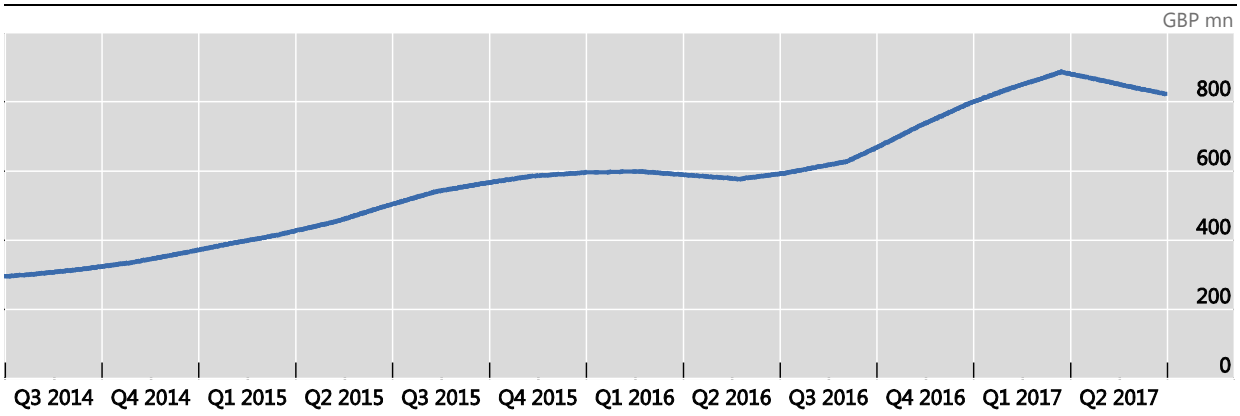
In the UK, data from the Peer-to-Peer Finance Association (P2PFA) put total cumulative P2P lending (the largest segment of FinTech credit) to date at £8.4 billion ($10.9 billion) in Q2 2017, with £3.1 billion ($4.0 billion) in loans originated in the period Q3 2016-Q2 2017. Figure 2 illustrates that the total value of loans originated in each quarter from P2P lenders has grown over recent years, peaking at £887 million ($1.15 billion) in Q1 2017. Over the full year of 2017, the Cambridge Centre for Alternative Finance (CCAF) estimates that FinTech credit

[72] For the purposes of this discussion, FinTech credit is defined as credit activity facilitated by electronic platforms whereby borrowers are matched directly with lenders. This includes P2P platforms, which operate under a variety of business models whereby lenders and borrowers are matched either on the platform or through a partner bank, and marketplace lending, which may involve the securitisation of loans. See FSB and CGFS (2017).

(debt-based alternative finance) volumes were £5.5 billion ($7.1 billion), and a higher-bound estimation is that this was equivalent to 29.2% of all new loans to UK small and medium-sized enterprises (SMEs).[73]

Total new P2P lending per quarter in the UK

Figure 2



Source: P2PFA.

In Korea, there were 183 P2P lending platforms as of the end of December 2017, a more than ten-fold increase from 16 at the end of January 2016 when the collection of related statistics started.[74] The cumulative volume of P2P loans as of the end of December 2017 is estimated at 2.34 trillion Korean won (or $2.15 billion). This increased rapidly over 2017, although lending exhibited a temporary plunge in June 2017 after the government implemented the P2P lending guideline in May, which imposes an annual 10 million-won ceiling for an individual's investment in a single P2P lender. Volumes rebounded afterwards to return to the level prior to the implementation of the guideline in September (figure 3). P2P lending is attractive to Korean investors due to the high returns (15.7% on average in December 2017). Moreover, P2P lending platforms can make profits from brokerage commissions, without bearing risks of loss, by simply connecting investors with borrowers on their online platforms, and they can also minimise costs such as personnel and branch operation expenses. As P2P lending platforms are engaged in investment brokerage only, they do not bear any losses even if their repayments are delayed or they turn sour. Investment arrangement fees are 1 to 5% of the borrowed amount and 0 to 2% of the invested amount.[75] Among the types of P2P loans, real estate-related loans make up more than half of overall volumes.

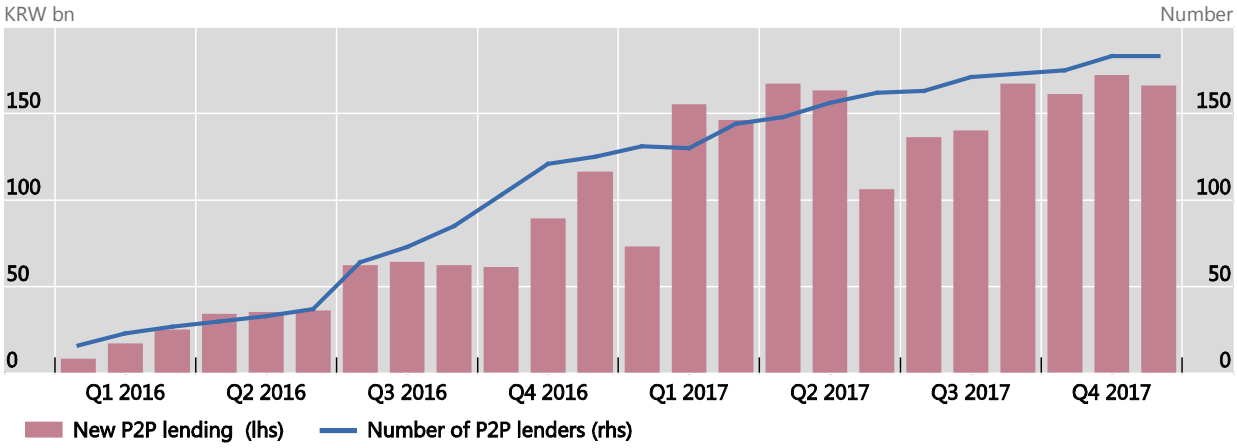
[73] CCAF (2018), "The Fifth UK Alternative Finance Industry Report," November.

[74] P2P lending platforms are one form of FinTech credit. According to Korea P2P Finance Association, the accumulated volume of P2P lending stood at 1.80 trillion Won ($1.66 billion) as of the end of December 2017. In this note, most statistics come from Korea P2P Finance Association, but the accumulated volume of P2P loans, monthly average of new P2P lending and the number of P2P lending platforms come from Crowd Institute (a private research institute operating a funding platform for P2P lending platforms) with a wider coverage.

[75] Source: Korea Consumer Agency, as of March 2017.

Lending volumes by P2P lending platforms in Korea

Figure 3



Source: Crowd Institute.

Since 2016, returns to investors have fallen and default rates have increased in China and the UK.[76] In Korea, the delinquency rate[77] on P2P loans has increased rapidly since September 2017. After fluctuating at less than 1.5% until August 2017, it rose to 6% in October 2017.[78] This was well above the delinquency rate of savings banks, which was 4.8% in Q3 of 2017. Meanwhile, the default rate[79] has increased steadily and reached 1.64% in December 2017. The Korean authorities note that despite the rapid growth of P2P finance in Korea, examinations of related risks have not been conducted sufficiently. The Korean authorities have noted that, to ensure that the Korean P2P lending market will develop in a sound and strong manner, the transparency and credibility of Korean P2P transactions should be secured by setting regulatory frameworks that take account of characteristics of Korean P2P finance without undermining the Korean P2P lending platforms' creativity and innovation.

[76] Claessens et al. (2018).

[77] The delinquency rate is a percentage of outstanding loans overdue for more than 30 days but less than 90 days.

[78] One of the large P2P lenders, which had offered investment products with one to three month maturity to attract short-term investors, had difficulties in its refinance due to the implementation of P2P Lending Guideline. The delinquency rate of its loans increased sharply from 0% in August to 49.0% in September and 82.7% in October.

[79] The default rate is a ratio of outstanding loans overdue for more than 90 days relative to the cumulative volume of P2P loans.

Annex 3: The impact of Yu'e Bao and other non-bank payment institutions' online money market funds on market structure in China

Chinese non-bank payment institutions (NPIs – see annex 4) started their online money market fund (MMF) businesses in 2013. Driven by easy access, extensive marketing, convenient payment services, and higher yield, Chinese NPIs online MMF products grew significantly in the past five years. For instance, the most popular MMF, Yu'e Bao ('leftover treasure'), managed by the Tianhong Fund, retails through the online platform of Alipay by embedding Tianhong's online system into that of Alipay. At present, Yu'e Bao has 170 million customers, and its asset volume amounted to RMB 1.5 trillion ($237 billion) as of June 2018, making it the largest MMF in the world.[80] Taking advantage of the absence of functional or integrated regulatory policy in China, these MMFs have expanded rapidly and assumed systemic importance in China. To many investors, these MMFs in China appear similar to traditional bank demand deposits. However, the Chinese authorities note that the size of these MMFs may pose potential systemic financial risks in China.

A1. Features of payment institutions' MMF business in China

An MMF offered by NPIs in China has the following features. First, NPIs sell online MMF shares through e-wallet apps to the NPIs' clients, while the sale proceeds are invested in MMFs. The Chinese NPIs market and sell the shares to their clients, while a separate institution designs the product, registers the units bought, and manages fund portfolio assets. Second, the Chinese online MMFs are widely (though not necessarily accurately) regarded as being as safe as bank deposits yet providing a higher yield. The online MMFs provide "T+0" redemption, no minimum investment requirements, and "free transfer" between bank accounts and the fund. Redemptions can be financed by the NPIs in advance, which could raise potential liquidity risks. The NPIs also offer value-added services by making online payments with MMFs shares directly. Third, the integrated services through these apps provide an easy and low-threshold access to MMFs. Customers can buy Yu'e Bao and similar MMFs shares through the integration of fund sale platforms with payment institutions' systems, often via smartphone, thereby simplifying the fund account opening, subscription, registration, and redemption procedures. Furthermore, with a minimum subscription of RMB 0.01 (significantly lower than traditional MMF shares), they have greatly reduced the investment threshold for investors, thus allowing greater convenience for small users and opening MMF shares to a larger client base.

A2. Chinese market impact and risk analysis

There are several types of impact from the online MMFs of Chinese NPIs on the financial system. First, the Chinese authorities note that online MMFs of Chinese NPIs have engaged in regulatory arbitrage by taking advantage of regulatory gaps. These MMFs are similar to deposit taking institutions, but are not subject to a similar regulatory framework. On the liability side,

[80] See CBInsights (2018); Zetzsche et al. (2018).

the NPIs accept money from the general public on current accounts that are repayable on demand or at short notice and at par. On the asset side, MMF assets are invested in structured deposits, negotiated certificates of deposit, corporate bonds, repo and other credit assets. The Chinese MMFs provide "T+0" redemption, which can be financed by the NPIs. Through their investment of client funds, Chinese MMFs provide short-term funding for the regular banking system as well as for other non-bank institutions, in some cases through chains of separate transactions. Chinese MMFs extend longer-term credit that is funded by assets that can be redeemed on-demand, which raises the potential for maturity and liquidity transformation. Yet these Chinese MMFs are not subject to macroprudential requirements such as reserve requirements and taxes, nor (until recently) to liquidity and capital adequacy requirements that are mandatory for deposit taking institutions (see below). Finally, they do not take part in deposit insurance. Because they are not subject to the same regulatory requirements as other MMFs or FIs, the online MMFs of Chinese NPIs have operational and compliance costs that are far lower than those of banks and similar deposit institutions.

Second, the online MMFs of Chinese NPIs have also profited from the interest rate spread between borrowing and lending rates, and pushed up financing costs for banks. These and other Chinese MMFs put a major slice of their money into banks as structured deposits or inter-bank certificates of deposit (CDs). They can profit from the spread by pooling the money that likely would otherwise go to the demand deposit accounts with commercial banks, and deposit them again with the commercial banks. One MMF manager recently stated in a meeting that "a larger size brings greater negotiating power. We can ask for higher interest rates." The assets held by the Chinese MMFs are currently around RMB 8 trillion ($1.3 trillion). These assets are highly concentrated and economically relevant as compared with the assets of RMB 80 trillion ($13 trillion) in the interbank market.

Third, the online MMFs of Chinese NPIs could raise potential liquidity risks due to potential maturity mismatches. The assets of these MMFs typically have maturities of several months, while investors can request redemption at any time. The "T+0" redemption is actually financed by the NPIs or the MMFs with their own cash in advance. In a period of market stress, if there were a sudden, significant demand for redemptions, a Chinese MMF might have to sell assets into a falling market at discounted or even fire sale prices to meet redemptions. If payment demand and redemption volumes were to surge to the extent that a Chinese MMF could only meet redemptions by selling the most liquid shorter term assets, the maturity mismatch in the MMF could increase, and pose increased liquidity risks.

With the ongoing rapid expansion, the online MMFs of Chinese NPIs are assuming systemic importance in China. In a period of market stress, these MMFs could exacerbate market stress through their potential impact on counterparties and on market confidence. Widespread redemptions across many significant MMFs in such a situation could result in a drop in demand for CDs and corporate bonds in China, which may exacerbate fund outflows from banks. Market data from 2013 to 2018 shows that the corporate bond yields and the redemption rates of MMFs are negatively correlated. The Chinese authorities note that the risks on an individual bank in China might spread rapidly to the rest of the Chinese banking system and give rise to

systematic risks, jeopardising the stability of the Chinese financial system and harming the real economy.

A3. Recent measures targeted at Chinese NPIs' online MMFs

To address the potential susceptibility of online MMFs of Chinese NPIs to heavy redemptions in times of stress, as well as to improve their ability to manage such redemptions and to increase the transparency of their risks, while preserving, as much as possible, their benefits, the People's Bank of China (PBC), together with the China Securities Regulatory Commission (CSRC), is implementing regulation based on the principles of 'substance over form' and 'same business, same rules.' The regulations follow the policy recommendations of IOSCO and FSB for MMFs, introducing liquidity fees and redemption gates to reduce potential run risks. In particular, in June 2018, the authorities announced measures with the following key components:

1. Online MMFs can only be sold by commercial banks or licensed MMF sale agents.

2. Capping instant T+0 redemption at 10,000 yuan (US$1,560) from a single fund and prohibiting NPIs or MMFs from allowing investors to make online payments with such funds shares directly.

3. Prohibiting NPIs or MMFs from financing the T+0 redemption with their own cash in advance to realise a de facto same-day redemption. Only qualified commercial banks are eligible for providing financing services to facilitate T+0 redemption of MMFs.

4. Prohibiting NPIs from engaging directly or indirectly in the sales of money market funds.

Annex 4: Non-bank payment institutions in China

A1. Overview of the payments business and non-bank payment institutions

There has recently been a rapid growth in the payments business in China. In recent years, non-bank payment institutions (PIs) responded to rising consumption by businesses and technological innovation to address the diversified retail payment needs of the public. PIs have played a supplementary role in catering to small-value payment scenarios. From 2013 to 2016, the volume of transactions processed by PIs increased from RMB 37.1 billion ($5.34 billion) to 185.5 billion ($26.7 billion), and the value increased from RMB 18 trillion ($2.6 billion) to RMB 120 trillion ($17.3 billion). The year-on-year growth rate of transaction volume and value reached 102% and 88% respectively in 2016.

Large-sized PIs grew even faster, leading to higher market concentration and prominent driving effects. In 2016, the top 10 PIs in terms of payment transaction value were (in descending order by value) Alipay, Tenpay, China UMS, UnionPay Guangzhou, All In Pay, ChinaPay, Ping An Pay, Yinsheng E-pay, Rui Pay and Easipay.

A2. Market Structure of PIs in 2016

In 2016, the top four institutions in terms of transaction value were Alipay, Tenpay, China UMS and UnionPay Guangzhou, with their combined concentration ratio (CR) and Herfindahl-Hirschman Index (HHI) reaching 0.73 and 0.19 respectively.[81] Based on the market structure classification by Bain & Company,[82] the payment service market in general shall be categorised as Monopoly Concentration Type Ⅲ. Based on the market structure classification of the US Department of Justice,[83] the market can be categorised as High Concentration Type Ⅱ. As such, China's payment service market is highly concentrated and polarised, and can be regarded as an oligopoly.

Looking at the internet payment service market, its CR4 and HHI4 reached 0.83 and 0.27 respectively, while CR2 and HHI2 posted 0.72 and 0.26 respectively. Based on Bain & Company classification, the Internet Payment service market fell into the category of Monopoly Concentration Type Ⅱ. Based on the classification of US Department of Justice, the market fell into the category of High Concentration Type Ⅱ. The Internet Payment service market was more concentrated than the third-party payment service market as a whole.

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[81] The combined ratio is the sum of market shares of a number k of firms. The HHI is a measure that takes into account the relative size of each market participant to characterise the distribution of companies in a market.

[82] CR4≥0.85: Monopoly Concentration Type Ⅰ; 0.75≤CR4＜0.85: Monopoly Concentration Type Ⅱ; 0.50≤CR4＜0.75: Monopoly Concentration Type Ⅲ; 0.35≤CR4＜0.50: Monopoly Concentration Type Ⅳ; 0.30≤CR4＜0.35: Monopoly Concentration Type Ⅴ; CR4＜0.30: Unconcentrated。

[83] Multiplying the original HHI index with 10000, if the outcome HHI≥3000, High Concentration Type Ⅰ; if 1800≤HHI＜3000, High Concentration Type Ⅱ; if 1400≤HHI＜1800, Moderate Concentration Type Ⅰ; if 1000≤HHI＜1400, Moderate Concentration Type Ⅱ; if HHI＜1000, Unconcentrated.

Looking at the mobile payment service market, its CR4 and HHI4 reached 0.97 and 0.52 respectively while CR2 and HHI2 were 0.94 and 0.52 respectively, indicating a very high degree of concentration. Alipay and Tenpay together accounted for 94% of the total market. The fact that HHI2 equalled HHI4 meant that except for Alipay and Tenpay, other mobile payment institutions held very insignificant market shares.

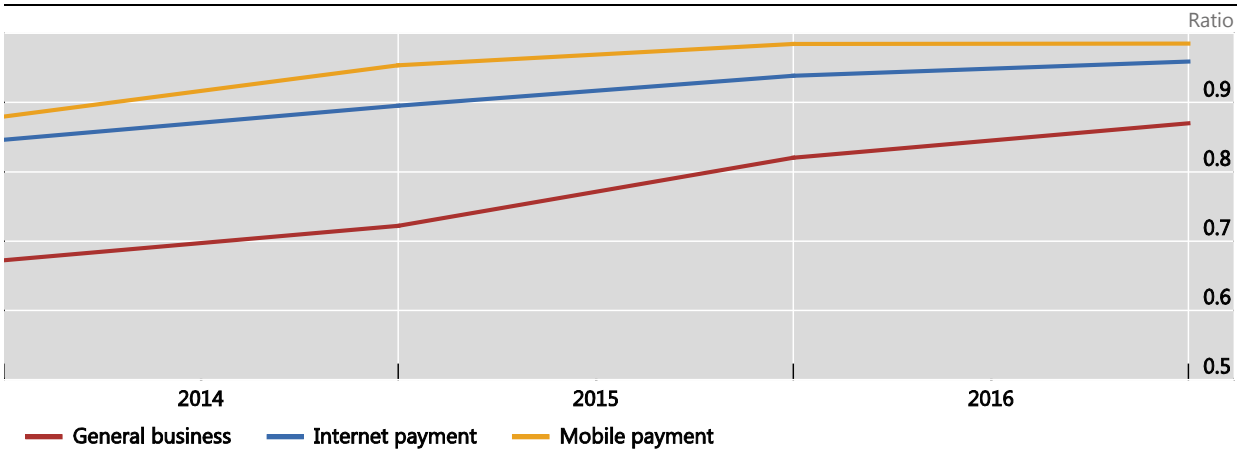
Table A1. Market Structure of PIs, 2016

	General Business		Internet Payment		Mobile Payment	
	Volume	Value	Volume	Value	Volume	Value
CR-2	0.8303	0.6006	0.9302	0.7220	0.9724	0.9377
CR-4	0.8701	0.7252	0.9588	0.8281	0.9852	0.9659
CR-8	0.9141	0.8228	0.9718	0.9035	-	-
HHI-2	0.3479	0.1816	0.4359	0.2624	0.4730	0.5198
HHI-4	0.3487	0.1893	0.4363	0.2686	0.4731	0.5203
HHI-8	0.3492	0.1919	0.4364	0.2702	-	-

Moreover, this concentration rose steadily by most measures from 2013 to 2016 (figure 4). Large PIs captured larger and larger market shares, leaving scant space for the medium and small institutions, and harming the interests of the entire industry.

Concentration ratio from 2013 to 2016

Transaction volume, CR-4 Figure 4



Source: People's Bank of China

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