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Disruptive Technology in Banking and Finance

An International Perspective on FinTech

Edited by

Timothy King

Francesco Saverio Stentella Lopes

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Foreword

As a financial services professional and fintech investor, lecturer, and board member, I was naturally honoured in 2020 when Dr. Tim King asked me to write a chapter and contribute with this foreword for a publication that he and his colleagues were putting together. I enjoyed collaborating with Tim on the UK challenger bank sector, and at the time I noted Tim's insights on the intersection of finance and technology.

Now reading carefully the final draft nearly a year later, I am struck by the timeliness and breadth of this literature and expect its readers will agree with this assessment.

First, this book spans the fintech domain and is well-timed following a pandemic year in which most of us, our co-workers, and our families moved online and went digital. Technology was not only actively used in many health-related endeavours during this period, but it also became fully integrated into financial markets via embedded finance, predictive tools for risk assessment, and open banking applications. This tech-led transformation underscores the strength and reliance of fintech, and this book is a very timely addition as a resource for both practitioners and academics/students alike.

The contribution of this book is not only its timeliness but also its breadth of material from notable thought-leaders and academics in this domain. After revealing historical disruptive trends and a taxonomy of digital innovation, the book then tackles cryptos, insurtech, and bank/fintech partnerships. To my eyes, these subjects have been absolutely brought to the foreground during the pandemic period and they will change the financial technology intersect going forward for good. The partnership issue is interesting: while commercial banks have scale, they often look to fintechs as an agent of cultural change and innovative solutions, as described in Chapter 6. The final three chapters consider the future for digital disruption in this fast-moving sector.

Given my touchpoints with fintech today, I believe readers will find that this book contributes to their understanding of the exciting and complex developments that are taking place today during these extraordinary times. Enjoy!

London, England

Walter Gontarek
Chairman & CEO of Channel, a London-based, technology-enabled provider of working capital to global companies, Visiting Academic Fellow at Cranfield University

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Walter Gontarek is the Chairman & CEO of Channel, a London based, technology-enabled provider of working capital to global companies. He is also Visiting Academic Fellow at Cranfield University where he lectures on financial markets, regulation, ethics and FinTech. He has invested into FinTechs and served on the boards of financial services and FinTech firms, currently serving as the chairperson of Wiserfunding. He holds a B.B.A. (Loyola), M.B.A. (NYU Stern) and a doctorate in finance (Cranfield). He may have a financial or other interest in firms or technologies mentioned within this article. The author is grateful to those individuals and firms that contributed to the article. Any errors remain with the author.

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CHAPTER 1

Introduction

Timothy King, Francesco Saverio Stentella Lopes, Abhishek Srivastav, and Jonathan Williams

FinTech has garnered the interest of the public, industry practitioners, regulators, researchers and policy makers worldwide. Its disruptive and transformative potential transcends country borders and is having real impact on the way financial services are provided. FinTech is forcing

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existing financial institutions to adapt. Consequently, financial institutions are investing and collaborating with those innovative start-ups who threaten traditional banking models.

An amalgamation of ‘finance’ and ‘technology’, FinTech continues to capture the imagination and interest of consumers of all ages, financial sector firms, governments, regulators, supranational agencies and standard setters worldwide. The word FinTech broadly refers to technological innovations applied to the finance sector and the word has gained entry to major dictionaries over the last few years—albeit no single definition exists. The Merriam-Webster dictionary defines FinTech as ‘products and companies that employ newly developed digital and online technologies in the banking and financial services industries’. As you, the reader, will come to learn throughout this text, FinTech firms have been grabbing headlines worldwide and for good reasons. For example, in November 2020, Chinese FinTech firm Ant Group was very close to an initial public offering (IPO) with an estimated value at listing of $37 billion United States (U.S.) dollars, only for regulators to intervene merely days before it was to begin trading. Similarly, in April 2021, Coinbase a major cryptocurrency exchange underwent a successful listing on Nasdaq with an initial market capitalization exceeding $50 billion U.S. dollars. This made Coinbase’s listing the biggest new US stock market entrant since Uber (itself major disruptor in another sector) in 2019. Other areas of FinTech have also attracted much international attention, such as, blockchain and cryptocurrencies, which have been sources of excitement, miscomprehension and concern—almost in equal measures among various stakeholders.

Against this backdrop, this tome provides you, the reader, with a thorough overview of FinTech across multiple geographies and a framework to understand the historical, current and future impacts of disruptive financial technologies for businesses and society. Although FinTech is dramatically transforming the nature of financial services and financial intermediation, its current and future impacts are largely uncertain. For instance, in many jurisdictions regulatory bodies and policy makers are starting to take a keen interest in developments, with recently implemented and future regulations expected to have a big impact on FinTech. For example, European regulators have been advancing new legislation designed to encourage ‘open banking’, which is anticipated to dramatically transform the nature of financial services by providing a more competitive financial industry landscape in which traditional financial services providers like banks are forced to compete with innovative start-ups and non-traditional industry players. Such changes may increase consumer choice and lower prices but also could undermine financial stability.

Across ten chapters this book will help answer the question is disruptive technology a force for good? As will be explained, on one hand, disruption, especially during times of heightened uncertainty, can represent a positive force for change that challenges established norms, improves efficiencies and helps to increase social and economic prosperity. On the other hand, technological disruption can have negative implications, for instance, concerns over risk management in FinTech firms and over the environmental impact of Bitcoin. Yet dear reader, as you will come to learn, disruption is often associated with both positive and negative effects, or, what we refer to later in this book (in Chapter 10) as 'light' and 'dark' sides. One salient example of this apparent 'double-edged sword' is the effect of increased competition in the market for funeral services in Germany during the 1990s.[1] In this case the entry of new digital entrants into the industry led to aggressive pricing strategies that focussed on low prices but at the expense of a more personal, and arguably sensitive, service. Moreover, a strong online marketing focus by these industry 'disruptors', forced many 'traditional' industry players to follow suit. The net result was a fall in the average cost of funeral services at the expense of a more personal and more reputation-based service.

While the term FinTech has only really gained prominence since the Global Financial Crisis (GFC) of 2007–2009, you will discover in this chapter and subsequent chapters, and come to appreciate that FinTech is not a new phenomenon. Instead disruptive technology, applied to financial, banking and insurance sectors, has origins much earlier. More recently, in the latter half of the twentieth century, revolutionary technologies, such as the invention of the World Wide Web, were a catalyst of the now fully realized and so-called 'digital revolution'. This crucial technology, which has its direct origins in a networked messaging system to facilitate communications between nuclear scientists worldwide, which itself utilized a United States (U.S.) government platform operational since the 1960s and then simply known as the 'internet', has come a long way since it was invented by computer scientist Sir Timothy Berners-Lee in 1989 while working at the European Organization for Nuclear Research (CERN). As the world increasingly realized its potential to disrupt societies and economies, the internet of things (IoT) has evolved from humble roots to become a key enabler of the Fourth Industrial Revolution, and a delivery channel for many of the FinTech developments we are experiencing today.

The slightly provocative title of this book, *Disruptive Technology in Banking and Finance: An International Perspective on FinTech*, aims to highlight the fact that FinTech, almost by definition, encompasses the concept of 'disruption'. Across ten chapters this book provides an in-depth treatment as to how FinTech, and related concepts such as BigTech, InsurTech and RegTech, among others, are disrupting the finance, banking and insurance sectors. This book shows how traditional players, or 'incumbents' are increasingly facing new challenges from disruptive technological innovations. For example, as discussed in Chapter 4, the Fourth Industrial Revolution (technological innovation) is transforming business models and enabling new ways of communication and information sharing in the insurance sector. As explored in Chapter 7, one challenge being faced by traditional banking intermediaries relates to the emergence of so-called new Challenger Banks, which are disrupting the banking sector by focussing on the digital delivery of more streamlined and customer-focussed banking and financial services. These Challenger Banks either offer the same digital solutions and products as traditional incumbent banks or specialize in specific products or services.

The book has been written in such a way so as to build a framework in which FinTech can be better understood from the perspectives of the main drivers and enablers of technological disruption in the banking, finance and insurance sectors, while considering the GFC and the recent Covid-2019 pandemic. It is our intention that the 'tool-kit' and framework we develop in this book will itself be a driver and enabler of further 'innovation'—in this case a desire to expand your reading further and become involved, or further involved, in the exciting FinTech industry and revolution.

1.1 FinTech: Covid-19 and the Global Financial Crisis (GFC)

The world fundamentally changed in the year 2020. On 31 December 2019, the World Health Organization (WHO) first reported the existence of a new and serious virus caused by a newly discovered coronavirus called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)

(World Health Organization, 2020).[2] This virus, now commonly known as Covid-19, has spread rapidly across the world with seemingly no regard for country borders and continues to impact countries in all regions—emerging and developed alike. At the time of writing in spring 2021, the Covid-19 pandemic continues to impact economies and societies worldwide. It is widely thought that its effects will be long-felt and deep, and undoubtedly form the basis of much interdisciplinary future study and research. Even before the Covid-19 pandemic, FinTech had been radically transforming the nature of economies and societies across the globe. As we will discuss throughout this book, the pandemic has already acted to accelerate some pre-existing FinTech trends as well as creating areas of new growth and innovation. The trend is towards a more 'digitalised', decentralized and borderless world, which, arguably, makes the future potential of FinTech even more significant.

1.2 Organization of Chapters in This Book

The remainder of this chapter offers a short overview of the topics covered by each of the ten chapters.

Chapter 2: *A Historical Perspective on Disruptive Technologies*. This chapter sets the scene by providing the reader with historical context, and a framework to understand current and future Fintech directions. It explores the origins of the ongoing FinTech revolution by examining the evolution of FinTech from its early stages in the late 1860s until today, and finally by discussing future directions.

Chapter 3: *A Taxonomy of FinTech Innovation*. This chapter builds on the theoretical framework established in this chapter, to convey the excitement and buzz surrounding FinTech, while demystifying some of the typographies and processes within FinTech. It offers detailed discussions of the various FinTech technologies and their applications and potential. It is organized in two main parts. First, the chapter outlines the importance of technological innovation in driving economic change through the discussion of several seminal works that shed light on the role of technological and financial innovations as driving forces of economic growth. The second part of the chapter uses data on filed FinTech patents to identify key areas of FinTech development. Four main categories of FinTech are identified and explored.

Chapter 4: *Cryptocurrency Mining Protocols: A Regulatory and Technological Overview*. The chapter focuses on cryptocurrencies and digital currencies. Beginning with a background to the digitalization of money, their origins are explored, as well as current and future applications. Current issues, such as regulatory concerns are also explored in the first half of the chapter. The second part examines blockchain technologies and the algorithms employed to secure and validate cryptocurrency transactions.

Chapter 5: *The Development of InsurTech in Europe and the Strategic Response of Incumbents*. This chapter introduces InsurTech as an increasingly important area of digital innovation that is transforming key processes and business models in the insurance industry. Just as FinTech is radically transforming the banking and finance sector, new technology-advanced entrants are challenging and collaborating with incumbents in the insurance sector who so far have largely struggled to adapt to their entry and new technologies. This chapter discusses such issues in the context of the European insurance sector, providing a detailed treatment as to how technological innovation is strongly impacting all phases of the insurance value chain, providing new opportunities and posing new risks.

Chapter 6: *FinTech and Banking: An Evolving Relationship*. Given the degree of overlap between FinTech and Banking, this chapter lays the foundation of how these two streams are inter-related. It discusses how FinTech is disruptive to the banking sector, while also explaining that a collaboration between the two has the potential to yield social welfare benefits. The final part of the chapter puts forward likely scenarios for future banking and financial services providers, and how relations between FinTech and banking will continue to evolve in the future.

Chapter 7: *FinTech Cultures and Organizational Changes in Financial Services Providers*. Building on Chapters 4 and 5, this chapter offers a sociological perspective on how the development of innovative technology results in the transformation of financial institutions. It discusses how FinTech cultures emerge, linked to organizational designs, and enable and/or constrain a financial institution's capacity to operate and compete successfully. One of the key areas of discussion is how banks are responding to outside FinTech threats through open innovation and collaboration, which are serving to enhance the extent and quality of banks' product offerings and customer service.

Chapter 8: *Digital Disruption: How the Financial Services Landscape Is Being Transformed*. This chapter gives a practitioners' perspective on how FinTech is shaping financial sectors and economies worldwide. Written by a leading practitioner, Dr Walt Gontarek, the chapter draws his insights as well as those from other leading practitioners to deliver industry-led insights into the main challenges faced by incumbent financial institutions, reporting on the digitalization of several financial services sectors before exploring the role of key stakeholders, including the regulator.

Chapter 9: *FinTech and Regulation: From Start to Boost—A New Framework in the Financial Services Industry. Where is the Market Going? Too Early to Say*. This chapter discusses the role of regulation and supervision in the European banking and financial sector. It begins by offering an insight into the heavily regulated nature of the banking sector, before discussing the regulatory concerns of how FinTech can affect banking institutions. It explores recent regulatory initiatives, including the introductions of the General Data Protection Regulation (GDPR) and Payment Services Directive 2 (PSD2) in Europe. Moreover, key policy discussions and reports are introduced to the reader, facilitating understanding as to how regulations may evolve in the future. The chapter concludes by exploring the challenges regulators will face in the future as to how best to balance innovation, financial stability and customer trust.

Chapter 10: *Bigger Fish to Fry: FinTech and the Digital Transformation of Financial Services*. Building on discussions of regulations in the banking and financial sector, as well as how and to what extent to regulate FinTechs from Chapter 8, this penultimate chapter provides a comprehensive economic analysis of regulatory policies and initiatives designed to support FinTech start-ups. It makes the crucial point that although regulatory policies can deliver benefits, to date they have lacked coherence. From this perspective, the chapter calls for policy makers to deliver policies that focus on the broader and more significant challenge of digital transformation using digital technology to address market and organizational failures across financial services, taking into account governance challenges that undermine digital transformation of finance.

Chapter 11: *Conclusion: FinTech—A Perfect Day or Walk on the Wild Side?* The book concludes by examining the ‘light’ and ‘dark’ sides of FinTech through the lens of the supranational regulatory agencies responsible for monitoring the impact of developments in market structure on the stability of the global financial system. A goal of this chapter is to review and synthesize some of the key discussions from prior chapters as to how FinTech is challenging incumbent financial institutions and identifies benefits and risks associated with the democratization of financial services. Finally, the chapter outlines the state of current knowledge of the topic, synthesizing relevant data from various sources with predictions from theoretical models alongside empirical and survey evidence to shed light on how markets are evolving, and participants are behaving.

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Notes

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CHAPTER 2

A Historical Perspective on Disruptive Technologies

Rossella Locatelli, Cristiana Schena, and Alessandra Tanda

2.1 A History of Technology and Finance: From the Dawn of Technological Development in Banking and Financial Markets to the Birth of FinTech

Technology and finance have always had very strong links. Yet the technological evolution we have been witnessing since 2008, and the consequent advent of FinTech, is different, in the sense that technology has become

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a game-changer. The word FinTech conveys the idea of a combination of Finance and Technology. The definition of FinTech has been discussed by the literature and one of the most accepted definitions is the one provided by the Financial Stability Board (FSB, 2019; Iman, 2020; Ratecka, 2020) who define FinTech as being "*technologically enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on financial markets and institutions and the provision of financial services*" (FSB, 2021). In simple terms, the FinTech phenomenon brings together financial and technological innovation to provide financial services.

Despite the relationship between technology and finance not being new, the speed and intensity with which technology is currently being developed and adopted by the financial system is unprecedented and has brought disruptive effects (on the topic see, among others Arner et al., 2017; FSB, 2019, 2020; IMF-World Bank, 2019; Tanda & Schena, 2019). New technologies can, at first, influence traditional banking activities, and help in developing sustainable business models. At the same time, the high degree of innovativeness of new technologies significantly influences the way traditional activities—which in the past were the exclusive domain of incumbents—are carried out and incites both new opportunities and threats. Indeed, the rise of players other than financial intermediaries offering financial services and products, namely FinTech and BigTech companies, has produced disruptive effects on the competitive landscape faced by incumbents and introduced new market structures. In essence, both the traditional view of financial intermediation as well as the perimeter of the financial system have changed, with new marketplaces ideated and introduced that bring together supply and demand of funds through innovative and disintermediated channels. These include activities such as lending and other forms of credit (e.g., invoice trading), as well as payments—both originally almost the exclusive preserve of traditional financial intermediaries. This disintermediation was also made more possible because of a shift towards greater standardisation of contracts, which especially affected the retail market.

This chapter analyses the impact of technology on the financial system over time from the late 1800s until present. It discusses the main events that, over time, have transformed the business models of intermediaries and other players operating in the financial markets. The analysis details three "interpretations" of the process of digitalisation of the financial system, namely:

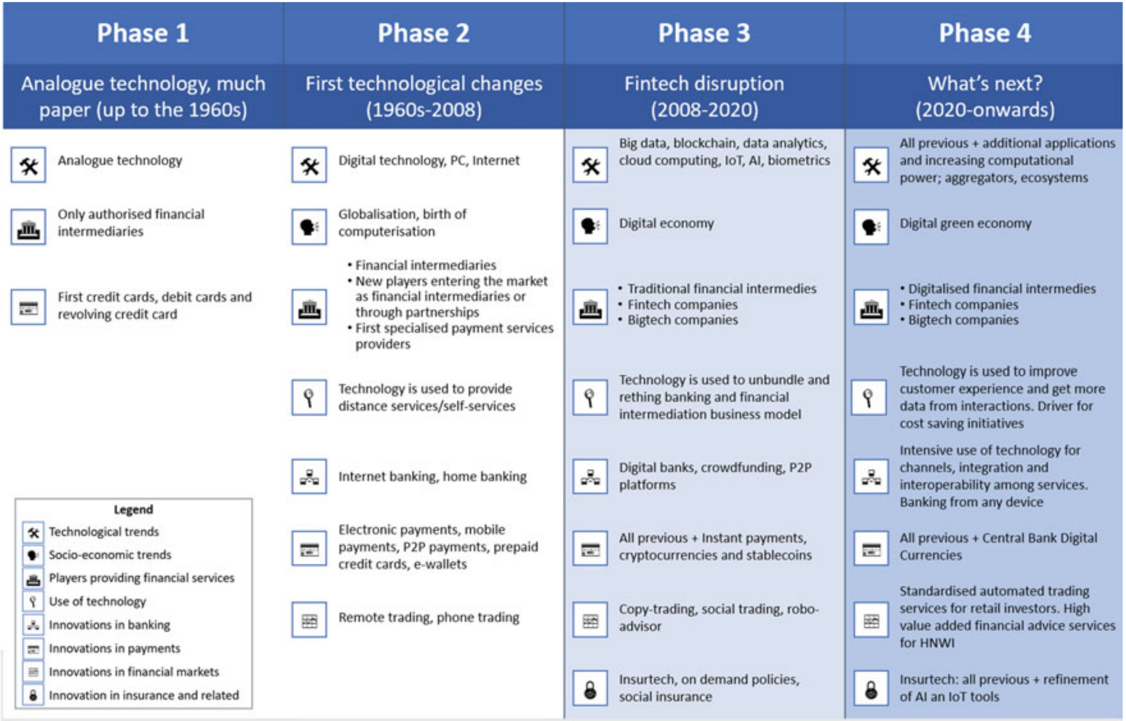

Fig. 2.1 Four phases of historical development of the relationship between finance and technology (*Source* Author created)

1. the impact of technology on internal processes of banks and securities markets;
2. the impact of technology on innovation in financial products and services;
3. the impact of technology on the competitive environment and wider changes in the financial sector.

When examining the relationship between technology and the banking and wider financial sector the evolution of regulation must be kept closely in mind. Regulation acts as an enabling factor for relevant institutional changes but may also leave "empty spaces" that are used to design innovative solutions that lever on regulatory arbitrage.

Academic literature proposes several different representations of the evolution of the relationship between finance and technology. In this chapter, seeking inspiration from Arner et al. (2017), we advance an alternative and updated paradigm that comprises of four phases (shown in Fig. 2.1). This forward-looking framework also outlines possible future developments extending beyond the COVID-19 pandemic, which also impacted the operations of financial intermediaries.

2.2 Phase 1 (Up to 1960s) and Phase 2 (1960s–2008): From Zero to Hero

2.2.1 *Phase 1 (1860s–1960s): Analogue Technology, Much Paper*

The relationship between technology and finance can trace its roots back to the period from 1860 to 1960s (Phase 1—Analogue technology, much paper). During this period the financial services industry was characterised by extensive use of analogue technologies coupled with substantial use of paper documents and manual processing (Alt et al., 2018; Arner et al., 2017). Technology was being developed and implemented but appears primitive and rudimental compared to today's standards.[1] In this long period, financial intermediaries operated as sole providers of financial and banking services and started early to adopt technology, but mainly for internal processes, while low- or no-technology was employed in the provision of traditional financial products and services. First attempts at

[1] For instance, a page with 25 words could be transmitted through telegraph, but the process took almost two minutes to be completed (Getsmarter, 2018).

technological advancements did little in transforming front-office banking services. For instance, telegraph and telephone communications were already in use in banking in the 1890s, but this essentially did not affect the bank-client interaction at branches (Bátiz-Lazo & Wood, 2002). In fact, these solutions did not support the option of conducting transactions remotely and bank–client transactions and orders were mainly based on paper documentation and in-person interactions.

Despite this, we can cite some interesting examples of technological innovations implemented by the banking industry. Among others, the pneumatic capsule transportation was developed, and it was adapted to the banking business in the late 1800s to allow customers to withdraw and deposit money at their banks directly from their car (Judd, 2017). This can be considered the very early version of the ATMs introduced later in Phase 2 (1967). Accounting machines were introduced in 1920s to provide balance on accounts and adopted by some very large banks. The first tabulating machines were then introduced in the 1930s but limited to the accounting aspects of banking business (Bátiz-Lazo & Wardley, 2007).

Also, the first credit cards were invented in Phase 1: in 1950 the first international credit card was introduced in the market by Diners Club. The card was invented after the famous episode of Frank McNamara (the inventor) forgetting his wallet during dinner and later on ideating a card that charged the purchases made during a month at the end of the following month. In 1951 Diners Club had 42,000 members in the US. In 1959 Diners Club reached one million members and listed on the New York Stock Exchange (Diners Club, n.d.). Meanwhile, also American Express card was introduced in the market (1958). The first credit cards relied on manual verification of the information (with possible errors) and were not based on digital technology (Fig. 2.1). The credit card presented, in fact, raised letters and numbers (like today) that were processed by a small printing press to imprint the information onto a two-sheet, pressure-sensitive piece of paper. One of the two paper was for the seller that input the information into a computing system to perform the debit order (IBM, n.d.).

Securities markets were essentially physical places where traders met and concluded transactions; the physical presence was a prerequisite to perform trades on financial assets or commodities. The pictures of the trading floors full of men and women yelling orders of long and short positions have become a part of the history of Stock exchanges. The New

York Stock Exchange (NYSE) and the London Stock Exchange have been existing since the late 1700s; in the late 1800s and the beginning of 1900s the early versions of the two of the most famous indexes were created: Dow Jones Industrial Average in 1896 and the Poor's Index in 1926 (to become later on S&P 500). In the early twentieth century, the standard for transmitting price and indexes information was the Morse code ticker (invented in 1867) that allowed information to be transmitted almost instantly. In 1925 the Translux Corporation moving electronic display was introduced and in 1959 the electronic quote terminal was already available to display prices of securities (Grody & Levecq, 1993). On the NYSE, prices of securities and indexes were also broadcasted via radio and IBM punch cards were used to calculate the closing price for broadcast (NYSE, n.d.).

2.2.2 *Phase 2 (1960s–2008): First Technological Changes*

In the following decades (Phase 2—First technological changes: years 1960s–2008), digital technology developed in the information and communication sector and enabled various inventions and innovations that gradually evolved up to the early 2000s and still exist today (although improved). These included personal computers, the internet and mobile communication technology. It was 1965 when some large banks in the US and UK moved to electronic data processing and adopted the first computers in the branches, also for internal network purposes (Bátiz-Lazo & Wood, 2002). From then, many technological innovations were adapted and applied in the financial and banking industry gradually and slowly transforming it into a digital industry. Since the 1980s banks became large customers for computers and related applications, overcoming other industries (see e.g., Quintás, 1991).

During the last two decades of this phase (the 1990s and 2000s) regulated financial intermediaries increasingly began to incorporate new technologies to offer their customers and clients financial products and services remotely (internet banking, home banking and online trading platforms) (Ratecka, 2020). This led to the introduction of self-service banking for low value-added transactions (like payments or money withdrawal and deposit), according to which customers could initiate many banking functions remotely and without human intervention, thereby saving banks' human resources for more value-added services, such as financial advice or lending contracts. The first steps towards digitalisation during this period also applied to payment services, with a surge of electronic payments and payments supported by the internet (both mobile devices and computers) (Arner et al., 2017). Furthermore, the dematerialisation of securities, allowed by regulatory changes, also promoted the abandonment of paper as well as a gradual decline in the importance of in-person trading at centralised stock exchanges and an increase in Over-The-Counter (OTC) trading (Arner et al., 2017; BIS, 2011). The change was driven by technology, but in this case, the underlying innovation was in itself simple. It was the possibility to include the rights of financial securities not in a certificate made of paper, but instead digitally encoded within a computer. This fundamental transformation was also made possible by the change in the regulatory approach to the concept of the legal value of a security, hence outlining how technology and regulation can both shape changes in the financial sector.

Technological adoption in the banking and financial markets also led, over time starting from the 2000s, to a process of rationalisation of the branch structure of banks and, in general, of the territorial presence of financial intermediaries (at European level the process was also stimulated by several deregulation initiatives). Besides, the broader objective of improving the efficiency and profitability of financial intermediaries (Boot et al., 2020) led to aggregation achieved with different timing in the various markets, through mergers and acquisitions between credit institutions. At this stage, however, consolidation occurred within regulated entities and technology was employed to improve efficiency and compete with online banking services of other banks. The main innovations were in fact promoted and applied within the banking market, without disrupting the competitive landscape, even in cases where new banks were established and operated exclusively online. Nevertheless, this was a period when some specialised internet-based financial entities began to emerge in the payment services provision (such as Paypal founded in 1998).

2.2.2.1 Banking Services

When examining the modern history of basic banking services, a major radical innovation was the development of internet banking or home banking. This itself was made possible by major technological developments in the twentieth century including personal computing and the internet, which provided the genesis for home banking (Cronin, 1998). Regulation also affected internet and remote banking (e.g., phone banking) from an operational point of view, allowing for interactions between clients and bank without physical presence. Without this type of intervention, the mere technological innovation would have not been applicable to regulated banking services.

The first rudimentary home banking services date back to the 1980s, when some of the major US banks allowed remote access to their services through a system called videotext (Hunter & Timme, 1992). In Europe, home banking was at first introduced in the United Kingdom through a three-way partnership between the Nottingham Building Society (NBS), the Bank of Scotland and British Telecom. The service provided allowed customers to carry out basic transactions, such as money transfers between accounts and bill payments (Chou & Chou, 2000). Even at that time, the adoption of technological innovation, i.e. internet banking, posed critical questions and challenges to banks. Credit institutions had to equip themselves with costly and embryonic information technology (IT) infrastructures to provide high-quality services at a time when the internet was not as widespread (and fast) as today and security systems were less resilient to cyber-attacks—although these were less frequent and more basic (Chou & Chou, 2000). The challenge for banks during this period also came from the breakdown of the traditional boundaries of the locally geographically segmented competitive arena, as customers could choose banks located far away from their region and access services via the internet. The success of internet banking is found in the advantages it brought to bank consumers, such as allowing customers to carry out transactions remotely without the need to visit a branch. For a majority of customers, it represented a considerably easier and faster way to access basic banking and financial services. The benefits for customers then, and similarly today, are widely discussed in the academic literature compared with perceived risks, among which privacy and cyber risks emerge as especially important (Kuisma et al., 2007; Lee, 2009; Sathye, 1999). Finally, internet banking was also the basis for the spread of additional services characterised by self-service banking, such as electronic payments and online trading. Taken together, such developments have also placed greater onus on banks to improve customer service, cross-sell and increase efficiencies as competition has intensified over time.

2.2.2.2 The Evolution of the Payment System and the Birth of the New Customers

The payments system has experienced profound transformations over several decades, especially during Phase 2, which have led to the creation of alternative payment methods, and, which, have gradually become more efficient and accessible to customers. In fact, the payment sector is one of the first sectors to be affected by technological evolution and was the first to be revolutionised even during Phase 1 (Fig. 2.1) (through credit cards). In this sector, the number of start-ups and large companies that have specialised in payments through technological systems (payment through the internet, e.g., Paypal) is high and seemingly ever-increasing over time (CPSS, 2012).

The payment system experienced its first great transformation when credit card payments were introduced.[2] It must be underlined that the innovation in the payment system through the introduction of credit cards does not lie exclusively in the way the transaction is settled (i.e., without using cash, but rather through a plastic card and the collection of information on the current account of the debtor or purchaser of the service) but rather the real innovation comes with the possibility of making purchases and settling the transaction while obtaining credit from the bank at the same time. This payment instrument gives access to another financial service, which is that of credit for the purchase of goods. By the end of the 1950s (Phase 1), several types of credit cards had already been created, including so-called revolving cards.[3] From a technological point of view, however, the first credit cards did not have this “instantaneousness” of credit and payment because paper instruments were used to make payments (through embossing machines) and the information retrieved from the card had then to be processed manually. An important step forward was made in the following decades (during Phase 2) with the introduction of the magnetic stripe on cards, and then the microchip, which allowed for digital recording of payment (and the credit). From a technological point of view this was enabled by the development of digital networks and point of sales terminals (Bátiz-Lazo & Wood, 2002).

Another important innovation that strengthened the role of the banking system in settling transactions was the invention of the Automatic Teller Machine (ATM). The first ATM was installed in 1967 outside a branch of Barclays bank in London, UK, and gradually became more widespread over the following ten years. In 1984 in the UK there

[2] The history of the birth of credit cards has been reviewed several times in the literature and more recently by Agarwal and Zhang (2020).

[3] A revolving credit card allows an account holder to borrow money up to an agreed limit.

were around 14,000 bank branches and 6106 ATMs, while in 1994 the number of branches declined to around 10,700 and the number of ATMs grew to 15,180 (Collet & Maher, 1997 in Bátiz-Lazo & Wood, 2003). A key enabler of ATM growth was a technological innovation introduced by IBM that allowed ATMs to be linked to credit cards (through the magnetic stripe and microchip) (Arner et al., 2017). The number of ATMs in the world grew substantially over this period. Other reasons for the growth of ATMs during Phase 2 were an increase in the number of banking services available through ATMs beyond cash withdrawals, including deposits, payments for third-party services such as transport tickets, telephone top-ups, etc. Recent estimates show, however, that the number of ATMs worldwide will not always grow at the same rates experienced throughout Phase 2, and in fact, in many countries such as the UK the number of ATMs has declined significantly in recent years. Simultaneously, POS (point of sale) and other payment methods (such as direct debit) have developed remarkably (Sahay et al., 2020). ATMs are therefore losing their initial primary function and gaining a new role as an alternative access point to traditional branch banking services for customers, allowing them to carry out simple transactions quickly and independently, in line with the idea of the self-service bank already cited.

The development of the internet and internet payments represents a further boost to the spread of electronic payments (Berger, 2003). In the early 2000s, the first companies specialising in electronic payments were established, such as Alipay in China, which was to become a Techfin giant within a few years, and Paypal in the United States, to name a couple.[4] Technological development makes payments safer and more convenient and leads banks to lose—gradually—their central role in the payments system. This phenomenon lives its most outbreaking development in the next Phase 3 (see paragraph 3).

[4] Long before that, in 1980s a top retailer in the US (Sears, Roebuck & Company) incorporated an investment company and a real estate broker to provide financial services (e.g., credit cards and insurances) in its stores under the label "Sears Financial Centres". The diversification strategy, however, did not prove effective, and the financial arm of the company was sold after a huge loss in 1992 (see Bátiz-Lazo & Wood, 2002 for a detailed reconstruction).

2.2.2.3 Trading Services Become More Electronic

As for traditional banking services the breaking point was the establishment of online banking services, a similar threshold was reached in trading and asset management services with the introduction of electronic trading in 1969 when Instinet launched a fully automated system through which US securities could be traded (Stoll, 2006). After the first attempts at phone trading and remote trading, the transactions of securities and assets moved to a completely digitalised system. The first electronic stock exchange opened soon after in 1971 when NASDAQ was founded by the National Association of Securities Dealers (NASD).

The introduction of electronic securities trading brought significant benefits in terms of market efficiency (witnessed, for example, by the reduction of the bid-ask spread between the late 1990s and the early 2000s), reduced transaction costs and increased competition between trading venues (see Stoll, 2006). At the same time, the landscape of players offering asset management and investment services changed, with a growth in numbers and assets under management of specialised intermediaries (fund managers); however, these were still all authorised financial intermediaries (see Boreiko & Massarotti, 2020, for a broader discussion).

With Phase 2 of digitalisation, trading systems have become more diversified, evolved and sophisticated, with technology affecting trading strategies and negotiation techniques. As an example, the market saw the emergence of Algorithmic Trading (AT) systems, which involve the use of algorithms by human traders, and High-Frequency Trading (HFT) systems, which allow for automated machine-driven trading without the presence of a human trader—with automated systems characterised by very short time frames and holding periods (Brogaard et al., 2014; Menkveld, 2013). The use of HFT methods has also been debated by academics, practitioners and authorities as a method capable of generating risks and distortions in markets (BIS, 2011; Gomber & Haferkorn, 2015; Shabbir, 2015). The speed of algorithms in evaluating and processing information and executing orders is not comparable to the ability of a human to perform the same transaction. Although HFTs typically do not compete with long-term investors, the transactions made in the market by HFT traders can influence prices and volatility, thus, also affecting the operations of traditional traders (Cole et al., 2015), with systemic and market stability consequences. The implications of which are still very much being explored.

In summary, despite these important innovations during Phase 2, securities trading remains based on systems that are managed by supervised and regulated entities, i.e. financial intermediaries, and disruption had to wait for Phase 3 when direct marketplaces become an alternative to the regulated financial markets.

2.3 Phase 3 (2008–2020): FinTech Disruption

We set the start of the contemporary FinTech disruption period as being from 2008 (Fig. 2.1). The global financial crisis (GFC) of 2007–2009, triggered by subprime mortgage events, instigated a deep crisis of confidence in traditional financial institutions and a change in consumer preferences. The latter is also the factor that feeds, together with the technological development and the availability of advanced technologies, the birth of the digital economy (Schena et al., 2018).

FinTech disruption is, in fact, not just the application of technological tools in the production and provision of financial services or products as was previously the case during Phase 2. Instead, in Phase 3, technology has become the enabling tool to disrupt the financial industry landscape, facilitating change in the nature of firms offering financial services (FSB, 2019). Industry players are no longer just traditional financial intermediaries, but also other (often unregulated) digital native entities that provide solutions that leverage advanced technologies and/or data processing capabilities and exploit misalignments or regulatory gaps to offer services not subject to regulatory authorisation but still fundamentally financial in nature (e.g., peer-to-peer lending). Start-ups (platforms), as well as pre-existing entities who have extended their financial services provisions in their offer (BigTech and TechFin), have entered the market and disrupted traditional business models. Such firms have experienced growth so rapid in the marketplace for financial services (through partnerships or as competitors to established providers) that they have caught the attention of policymakers who have voiced concerns about the implications for financial stability and consumer protection.[5]

The disruptive nature of FinTech poses new and major challenges for financial intermediaries and presses them to react promptly and efficiently

[5] Regulators and supervisors have questioned whether to include these entities and their activities within regulatory frameworks (already existing or newly designed) (Hernández de Cos, 2019).

to new and emerging trends in the markets of financial services and products. Consumers are now increasingly aware of the alternatives offered by innovative competitors, and their experiences with FinTech and BigTech companies are also affecting their expectations of banks.

Also due to the demand for improved customer experiences and more innovative and cheaper financial and banking services, the technological revolution is affecting multiple stages of production and distribution of financial services and products (Carney, 2017)—including impacting the design of new business models in banking. Traditional banks also face an additional challenge: the sustainability of lending-based business model in a phase of very low-interest rates worldwide which forces banks to look for more innovative solutions to recover efficiency and make up for falling margins. These include technological interventions and digitalisation of internal processes.

The second element of profound difference compared to the past, is the different speed of adoption and incorporation of technological innovations by the financial system (Schena et al., 2018). Innovations in processes and products can take place thanks to the diffusion of new technologies in the strict sense: big data, data analytics, blockchain technologies, artificial intelligence, Internet of Things (IoT) and cloud computing systems that enhance data storage and processing capabilities[6] (Arner et al., 2017; Frost, 2020).

Phase 3 presented an innovation of process and products, although with different speed and degree of development in the different markets, depending on the level of maturity of the financial market, the action of the regulation and the rate of technological adoption of each country. Beside the innovation of channels and processes that is transforming financial intermediation business models, product innovation occurred likewise, with the birth of cryptocurrencies and stable coins, to cite a couple. Compared to the past, the degree of development of the financial systems is greater and this also allows to incorporate innovation more

[6] The development of the so-called "public cloud" is crucial in this respect. Numerous agreements have been concluded between incumbent banks and technology providers for the use of cloud systems (e.g., Google entered into agreements with Intesa Sanpaolo and Deutsche Bank for cloud services) (Deutsche Bank, 2020). The market power of BigTech is in this field considerable: for instance, Amazon Web Services is the largest provider of cloud services in the world, including to many financial institutions. Other large providers are Microsoft and Google, while in Asia, the main player is Ali Cloud (part of Ant Group) (Frost et al., 2019).

rapidly. In some cases, the competition exerted on innovations takes the form of process innovations or targets specific customers, such as the unbanked.[7]

In the forthcoming subsection (2.3.1), we continue our discussion of Phase 3 by providing a more detailed expose of the actors involved in this stage of digital transformation.

2.3.1 The FinTech Companies

As previously mentioned, the most significant disruption occurring during the third phase (Fig. 2.1), has been the changing nature of entities providing financial products and services and the related disruption of traditional business models. Especially in the first part of this period, many FinTech firms have operated by exploiting unregulated spaces (EBA, 2017; FSB, 2019), while competing with traditional financial intermediaries for specific services, starting with payment services. By unbundling financial services, they position themselves as substitutes for the traditional intermediation channels, often offering a direct channel for obtaining financial resources as debt or equity (digital marketplaces). The first equity and lending crowdfunding platforms operated according to this model. Yet over time, in some countries, the business model of direct marketplaces has evolved. We now take a closer look at how FinTechs transformed banking and financial services.

2.3.1.1 Lending Services and Debt or Equity Crowdfunding

In the areas of lending, debt and equity financing services, the third wave of digitalisation has heralded real innovation in business models—beyond digitalisation of the channels that followed the spread of internet banking. Equity and lending crowdfunding marketplaces have emerged, allowing individuals and businesses the opportunity to raise capital or to get loans, respectively, from the "crowd" of investors (Claessens et al., 2018). The platforms emerged after the 2008 financial crisis, partially as a response to the fall in confidence in the traditional intermediation system and are part of the phenomenon defined as the "democratisation of finance". Individual investors can now decide how to allocate their wealth, also targeting initiatives with social or environmental impacts.

[7] Please refer to Chapter 10 "How Is FinTech Shaping Economies?" of this volume for a discussion of the different impact of FinTech in different countries.

The underlying technology is often simple (a website), but this can be accompanied by the development of very sophisticated algorithms for estimating credit or counterparty risk using both big data and alternative dataset (CCAF, World Bank and World Economic Forum, 2020). As these techniques are still relatively new, it is perhaps too early to say whether they are in general better and more reliable than traditional models in the long run. However, they are attracting considerable interest also by BigTech companies and incumbents.

The emergence of numerous equity and lending crowdfunding platforms worldwide (e.g., Crowdcube, Indiegogo, Kickstarter), has led these entities to develop different business models (Ehrentraud et al., 2020; Ferrarini, 2017). To be brief, platforms can act as pure brokers in the relationship between provider and taker of funds (digital marketplace) or they can participate with their own funds in the provision of loans, debt or equity to companies or individuals. Others may also include securitisation schemes of loans subscribed through the platform in favour of institutional investors (FSB, 2017b). In many jurisdictions, when a platform provides loans directly it enters the operational sphere of financial intermediation, which is reserved by law for financial intermediaries and, therefore, must apply for authorisation as a credit (or financial) intermediary.

The existence of multiple business models and different regulatory provisions has created conditions of strong competitive misalignment not just for both credit and other financial intermediaries, but also between platforms themselves—with serious consequences for investor protections.[8] For example, in the European Union, a long debate has led policymakers to the awareness of a need to harmonise the equity and lending crowdfunding sector. Regulatory efforts are summarised by the "Regulation on European Crowdfunding Service Providers (ECSP) for

[8] Particularly illustrative is the case of China, where the number of platforms has grown exponentially, especially in lending, leading to a speculative bubble. Numerous cases of bankruptcy highlighted inexistent or inadequate risk management policies of platforms. While huge losses of investors induced supervisory authorities to regulate some areas of activity surrounding peer-to-peer lending platforms to protect customers. Besides these cases of poor risk management, the market also experienced cases of fraud, which also resulted in investors losing significant sums of money (Claessens et al., 2018).

business" entered into force in November 2020 and applicable from November 2021.[9]

2.3.1.2 *Payments and Money: From e-Money to Cryptocurrencies and Stable Coins*

In Phase 3, the payments sector evolved from Phase 2 innovations and has been characterised by intensive innovation and market growth, especially thanks to new non-bank players. These offer alternative and particularly convenient payment methods, in some cases completely free of charge, including transactions via mobile phones and mobile devices and allowing instantaneousness of transactions. The players in the market include mobile phone producers (e.g., Samsung, Apple), BigTech companies (including Facebook, Alibaba, Google) and telecommunication companies (e.g., Vodafone) (Azarenkova et al., 2018; Zetzsche et al., 2018).

More recently, FinTech and BigTech are contributing to such developments also from a technological point of view, making the payments market even more competitive and innovative. For instance, in recent years a significant proportion of online payments are being performed via non-bank institutions (DNB, 2020). In Europe, also the regulatory change on Payment Services Directive (PSD2) has also had a strong impact on competition. Specifically, because it authorised third-party providers to access bank data with customers' authorisation (FSB, 2019). Also, banks in Phase 3 began developing innovative instruments,[10] but their efforts were not able to contain the impressive growth of FinTechs and BigTechs in both in emerging and advanced economies (CCAF, World Bank and World Economic Forum, 2020).

Phase 3 also brought breakthrough innovation in the forms of blockchain technology and cryptocurrencies. Being born as an alternative

[9] Harmonisation and a common policy framework are, in the eyes of the European regulator, two indispensable tools to promote an ordered development of the crowdfunding market.

[10] Many banks implemented the capability of "instant transfer" of funds between current accounts; main players also invested in blockchain technologies. These latter include projects by JP Morgan for interbank payments, Santander for cross-border payments, and more than 100 banks that became part to the R3 consortium (including BNP Paribas, Credit Suisse, ING, and Unicredit) (Azarenkova et al., 2018; CB Insights data).

to legal money their emergence has led to various concerns by policymakers and the financial industry (Gomber et al., 2018; BIS, 2019b). Cryptocurrencies and digital currencies are among the most known and disruptive innovations of FinTech, representing a type of decentralised currency, based on blockchain technology. These include the well-known Bitcoin, Ethereum, Litecoin. Their initial diffusion has resulted in the development of numerous alternative virtual currencies including stable coins (Gomber et al., 2018). Although born as a candidate to replace money, over time the spread of cryptocurrencies as a means of payment has not reached volumes that would currently threaten legal tender,[11] due to highly volatile prices, limits to dissemination, difficulty of use and differences in legal and regulatory approaches. Unfortunately, in many cases, the cryptocurrencies have proved to be vehicles for illicit initiatives such as fraud and money laundering, which has prompted some jurisdictions to ban or restrict their use, in addition to seeking awareness among intermediaries and clients of the risks inherent in cryptocurrencies (EBA, 2014; ECB, 2012; ESAS, 2018; European Parliament, 2016). In general, the cryptocurrencies have been more successful as a speculative investment asset[12] rather than as an alternative to money (see for example: King & Koutmos, 2021).

The use of virtual currencies also offers numerous potential advantages, including the speed of execution of payments or money transfers and the security of payment traceability, if based on blockchain technology, which would also ensure benefits in terms of efficiency of cross-border payments

[11] Consider that the number of (physical) ATMs in the world from which it is possible to operate with virtual currencies is 11,756, some large online operators accept payments in Bitcoin (including some websites) and as of November 2020 BitCoin alone is accepted in 18,629 establishments (physical and virtual). However, it is interesting to observe the growth in the number of establishments worldwide accepting BitCoin in recent years: there were 15,601 in November 2018 (+19.4% over two years) and 8662 in November 2016 (+115% over four years) (data taken from www.coinmap.org).

[12] Cryptocurrencies have also become an instrument in raising resources for business start-ups or investments through ICOs—Initial Coin Offerings: by placing digital tokens based on blockchain technology, companies can raise funds in a similar way to an IPO. In this case, however, the investment is not directly in a security representing a share of share capital, but in a token, whose performance depends on the performance of the companies that issued it. ICOs are subject to the same critical issues as cryptocurrencies and, in addition, can be a vehicle for fraud (for a recent study on this topic, see Adhami et al., 2018; Toma & Cerchiello, 2020).

and financial inclusion.[13] To overcome the limitations and high volatility of cryptocurrencies, projects have been launched to develop stable coins, i.e. virtual currencies that replicate the performance of individual currencies or a basket of currencies or other assets (BIS, 2019a, 2019b; Giudici et al., 2020). However, as with traditional cryptocurrencies, stable coins also present challenges in terms of regulatory, supervisory framework, legal certainty and consumer/investor protection, as well as financial stability, monetary policy transmission effectiveness and fair competition, as highlighted in the report of the G7 Working Group on stable coins (BIS, 2019a). Central Banks also expressed interest in this type of virtual currencies and we provide some insights in the next paragraph.[14]

2.3.1.3 Asset Management and Investment Services

In Phase 3 the field of asset management and investment services further developed, accompanied by the entry into the market of new trading platforms. Advancements offered by these platforms included new trading strategies provided to retail customers, such as copy-trading systems, i.e. the possibility of automatically emulating the investment strategy of another person registered on the same platform. The platform, in this case, combines the trading function with a social aspect, which connects traders and shows the most successful trading strategies. Because of this such platforms are also often referred to as "social trading platforms" (FSB, 2017a). However, these platforms can entail higher risks for investors when they operate unaware of risks taken by the "copied" trader.

Advanced computational methods, including machine learning (ML) and artificial intelligence (AI), are also key to automated advisory procedures or robo-advisory services. Using data on investor's characteristics and preferences, algorithms provide asset allocation suggestions: usually identifying a risk-return profile deemed in line with an investor's (Boreiko & Massarotti, 2020; FSB, 2017a; OECD, 2017). Levels of automation differ based on the specific business model adopted by the robo-advisor and, in some cases, it is the human advisor who engages in providing

[13] As evidence of the importance devoted to blockchain applications, not only related to the topic of cryptocurrencies or payments, almost half of all tested blockchain applications refer to financial intermediaries (Hileman & Rauchs, 2017).

[14] For more detailed discussion of digital currencies, we refer the interested reader directly to Chapter 4 of this book.

inputs to the model and interpreting the results of the algorithm (robo for advisor).

Discussion around robo-advisor services also began among policymakers and supervisors based on the potential for automated advisory systems to generate distortions and herding behaviour. For example, an absence of human interaction could lead investors—particularly retail investors—to make excessively risky investments without being aware of it. Besides, an absence of human advisors could lead an investor to fall more easily into typical investment behavioural biases such as overconfidence and overtrading (Schena et al., 2018). These biases are important since they could affect the prices of financial instruments and, more broadly, financial stability. Supervisors and institutions also raised specific issues with respect to conflicts of interest and the transparency of algorithms—which must be accurate and robust (Ehrentraud et al., 2020; OECD, 2017).

For the time being, at the time of writing in 2021, the development of robo-advisor applications has remained limited and is mainly channelled through supervised financial intermediaries, who are required to comply (at least in Europe) with the Markets in Financial Instruments Directive (MiFID) provisions on profiling and suitability and appropriateness of investments and, more generally, with the relevant regulatory provisions on financial advice and financial investment services. Despite this, financial intermediaries have nevertheless been reminded by the authorities to pay particular attention in the case of investments made "remotely" or through robo-advisory procedures (ESMA, 2018; FSB, 2017a).

2.3.1.4 InsurTech

FinTech has so far also impacted the insurance (InsurTech) and, to a lesser extent, the pension fund sector. It has been claimed that new AI and Big data technologies are natural allies in the insurance business; however, in the initial Phase 3 Insurtech has seen less development when compared to banking and marketplace (crowdfunding) activities, but it is recovering quickly.

Apart from initiatives to digitalise channels, innovations are also affecting the business model. Among them the "social insurance" or P2P insurance: here insurance companies adopt a business model intended to make premiums cheaper, increase transparency and align the interests of all parties through the participation of different players, although these advantages appear to be hard to concretise (EIOPA, 2019). The model encompasses a traditional insurance scheme, but a refund of part of the premium is paid to subscribers if there are no claims in the group of underwriters (Cortis et al., 2019)[15] or part of the premium paid is intended for initiatives socially useful selected by the policyholders. The way insurance services and products are being distributed is also affecting the insurance intermediation business model. In some cases, the insurance products are becoming part of a 360 degrees experience of the customers and are being sold as *embedded* in the main product.[16]

Also, in this area of financial intermediation, new companies (InsurTech companies) have been contributing to innovation in the sector by developing alternatives and by putting competitive pressure on incumbents and/or by disrupting traditional business models (Greineder et al., 2020). Recently, partnerships between traditional insurance companies and InsurTech start-ups have gradually changed the nature of competition, as in the banking system (Cappiello, 2020); insurance incumbents are also investing in start-ups through venture capital backing or acquisitions (CB Insights, 2020). In other words, the innovation process in the insurance sector, just like in the banking industry, is moving towards an "open insurance" ecosystem, with exchanges of ideas, data and solutions between insurance companies, InsurTech start-ups, Technology companies and other institutions.[17]

As discussed, digitalisation has also enabled an expansion of supply through digital channels, but most importantly, the applications that have been developed for the insurance industry appear particularly interesting (Tech for insurance). These include IoT wearable devices for monitoring health conditions and lifestyles, chatbots and AI machine learning applications (Greineder et al., 2020). Such instruments are interesting because they can improve risk estimation and therefore premium determination.

[15] The most successful P2P insurance companies include German firm Friendsurance, US-based Lemonade and British firm Guevara.

[16] As an example, the car manufacturer Tesla in the US developed a service that includes insurance coverage, maintenance and driver assistance, while also collecting information on drivers' habits and behaviour to get more accurate estimates of risk linked to car insurance.

[17] Although there is no single definition of open insurance, we can refer to EIOPA's interpretation as an environment in which accessing and sharing insurance-related personal and non-personal data via Application Programming Interfaces (APIs) is allowed (EIOPA, 2021).

Technological advancements during Phase 3 have also enabled the development of on-demand or immediate subscription methods that allow customers to access particular risk coverage policies (e.g., travel, holidays, sports) on demand. Pre- and post-sales support via chatbot are also now quite common.[18]

2.3.2 The Role of BigTech Companies

The different nature of BigTech companies, compared to FinTech start-ups, has imposed unique challenges in the financial sector for intermediaries and contributes to innovation in a different fashion. BigTechs prior experiences in other industries have enabled them to develop seamless customer-centred interfaces. Just as importantly, BigTechs had an advantage in terms of their ability to exploit big data and advanced computational techniques in a way few financial intermediaries had done before (for many reasons, including infrastructure and regulatory requirements on data treatment) (Frost et al., 2019; Tanda & Schena, 2019; Zetzsche et al., 2018).[19] Because of this, Amazon, Google, Microsoft, Tencent, Alibaba (to name a few) have taken, during the latter period of Phase 3, dominant positions in the financial services landscape. They began by taking their first steps in the payments and lending sectors and, later, in investment, asset management and insurance sectors.

As said, for traditional banks and financial intermediaries, the entry of these operators in the offer of financial services and products is much more disruptive than the impact determined by the entry of FinTech companies, which, so far at least, has been sufficiently contained.

BigTech firms are producers of technology themselves. Leveraging important financial resources, BigTech companies invested heavily in research and development in technology and also develop technological products that they sell, among others, to financial intermediaries

[18] Especially because of the concerns linked to the diffusion of COVID-19, in the latter months of 2020 and early months of 2021 the part of the InsurTech sector focussing on life and health received much attention and also important rounds of investments by investment funds; these included both specialised investors and BigTech companies (CB insights, 2020).

[19] Their main competitive advantages are, in fact, their large and varied information set (big data) and their excellent reputations with their customers (Barba Navaretti et al., 2017; Bilotta & Romano, 2019; FSB, 2019; Schena & Tanda, 2019; Zetzsche et al., 2018).

and thus become preferred, if not exclusive, interlocutors for certain services deemed essential, such as cloud computing and data analytics services (Allen et al., 2020; FSB, 2019). For example, Ant Technology, an Alibaba Group company, operates as a technology producer and advisor to major Chinese financial intermediaries. Moreover, BigTech companies were also able to undermine banks in the provision of payment services (Chemmanur et al., 2020). BigTechs' market power in lending is especially strong in developing economies (e.g., some countries of South America, Africa and Asia), while it is growing but still limited in developed countries (Frost et al., 2019).

Financial services and products by BigTech can be offered through partnerships with incumbents (e.g., this occurred for Google, Apple, Facebook and Amazon) or directly, through controlled entities (e.g., by Tencent and Alibaba) that are part of a conglomerate. The existence of financial conglomerates is not new, since many industrial groups have created conglomerates over time (e.g., General Electric, Sony, etc.). However, the new financial conglomerates built by BigTech companies during Phase 3 ("Tech financial conglomerate") appear different (Tanda & Schena, 2019).

Today, BigTech companies seem to be primarily interested in customer loyalty, to which they try to offer a product to fit every type of need. Therefore, the creation of conglomerates that are also active in the financial sphere is part of a broader strategy of creating an ecosystem that becomes the single point of contact for customers: being able to offer answers to all their needs (both financial and non-financial) and even anticipate their requests (Tanda & Schena, 2019). To this end, BigTech firms, to offer financial products personalised and adapted to individual customers, use data collected from other business activities. These include online sales, which allow them to understand customers' lifestyles and standards of living (BCBS, 2018; Padilla, 2020). For BigTechs, the collection and processing capacity of information is key to the relationship with the customer; the latter is both a competitive advantage and the driver that leads them to develop further in the field of financial services (Carbò Valverde & Fernández, 2020).

These characteristics of BigTech and their expansion into financial services markets pose significant regulatory challenges and threats to system stability, which have stimulated discussion in the academia and among policymakers on the appropriateness of regulating the expansion of BigTech as we enter Phase 4. In addition, the behaviour of BigTech companies, over time, has not always proved to be entirely fair from anti-trust law or data treatment perspectives (BCBS, 2018; Maggiolino, 2019; Padilla, 2020). Going forward, how the threats of BigTech, on levels of instability and systemic risk created by their entry into the financial system, will be treated will also depend on the responses of regulators in terms of anti-trust law, privacy rules and financial regulation (Padilla, 2020). Overall, the expansion of BigTech in the financial system is worrisome from many perspectives, although it undoubtedly promoted competition and improved services in the eyes of consumers. Discussions at policy-maker level are currently quite intense (Carbò Valverde & Fernández, 2020; Frost et al., 2019; FSB, 2019, 2020).

2.3.3 The Incumbent Companies

In this third phase (Fig. 2.1) incumbents have been facing strong challenges, from many sides. Banks have been losing their role as main promoters of technological innovation in the financial banking markets. They have lost their predominance in the market for several services both globally (e.g., payments) and locally (e.g., small loans in developing countries), and have been forced to confront the competitive pressure exerted by FinTech and BigTech firms. More specifically, they have to meet digitalisation challenges and to rethink their business models and relationship with customers (Petralia et al., 2019).

The response of banks to the digitalisation process is very slow and complicated. First of all, banks face technological legacies stemming—in many cases—from the stratification of IT systems from different legal entities, which were subsequently merged into a single group (Tanda & Schena, 2019). Secondly, internal development entails large investments and risks. When investments are determined, a bank has to choose the most appropriate option on the market in terms of technological solution, which might not be the "best". Specifically, some banks may engage too early, and large digital transformation and initiatives may fail because they are not able to internalise the change. In general, larger banks generally possess more resources to invest in the adaptation of production processes, and this can be an advantage in the face of smaller local banks that might rely, instead, mainly on strategic partnerships (Tanda & Schena, 2019). A further obstacle to the digital transformation process lies in corporate culture: banks wishing to digitalise their business need to organise training sessions for staff currently working in the bank. Also they need to recruit new employees with strong skills and knowledge of relevant technology and in management of related risks (not only cyber risks) that the adoption of technology in the banking business entails at all organisational level (from operations to top management) (Aldasoro et al., 2020).

It is during Phase 3 that a majority of banks understood that digitalisation is an incontrovertible phenomenon and took steps to set digitalisation as a primary strategic goal. However, only a few intermediaries have been able to pursue timely and truly innovative lines of development (Locatelli, 2020; Tanda & Schena, 2019).

The first intervention has been the digitalisation of the distribution network. This represents a step forward from online banking and involves a rethinking of the way the banks interface with their customers according to market segment and type of services provided.[20] The new generation of internet banking services, compared to past models, has afforded a wide range of operations, from payments to requests for new products and services (asset management, trading, insurance, etc.), and, even, integration with the services of third-party partners of the banking institution. Also, these developments have meant that many requests made by customers could be handled with a substantial reduction of paper or completely paperless: thanks to smart contracts and other identification tools, such as digital signatures (DNB, 2020). The digitalisation of channels also responds to the need for banks to reduce the physical presence on the home market according to a wider cost-saving strategy.

During Phase 3, a considerable number of new banks, so-called "digital banks", opted for fully online business models[21] Within these business models banking services are based on smartphone applications or online platforms and allow normal banking operations to be carried out, with different models and degrees of autonomy. Some banks choose to allow only basic operations (credit transfers, salary crediting, balance check),

[20] Although internet banking is commonly used by different segments of the population, some age groups (older and elderly population) still prefer the physical channel (DNB, 2020; FSB, 2020; Lee & Shin, 2018).

[21] The proliferation of digital banks encouraged the ECB in 2018 to issue guidelines expressly aimed at FinTech credit institutions, which were later embedded in general guidelines (ECB, 2018). The intervention of the central bank was aimed at emphasising the characteristics that make an intermediary a "bank" and the need to act in the authorisation phase in a harmonised manner within the European market by all national supervisors.

while others offered more sophisticated offerings, including a wider range of services (e.g., payment of bills or tax forms, trading on securities accounts, subscription to third-party products etc.) (Deloitte, 2020). Digital native banks can be independent, i.e. not part of any banking or industry group, bank-owned (if they belong to banking groups) or set up by Techfin[22] (examples are the Chinese Mybank and Webank, owned by Alibaba and Tencent, respectively). Interestingly, in many cases incumbents also participated in the start-up of digital banks as minority investors directly or through venture capital funds, even in the case of independent banks (Tanda & Schena, 2019). This might occur also because the creation of a new digital bank constitutes a simpler and faster solution than in-house development, which is hindered by the internal incumbent legacies, and also better responds to attracting those customers more used to digital channels.

2.4 Phase 4 (Post-2020): What's Next?

Technological evolution continues at an impressive pace. This is also due to the "forced" push that the banking system experienced during the lockdowns imposed in several countries as a consequence of the COVID-19 epidemic. During this period banks had to continue their essential activities, in compliance with safety regulations established at country levels, when dealing with customers and employees. The lockdown and the spread of the pandemic made it no longer possible to postpone the digitalisation of channels for banks, even for credit institutions that had proved to be less technologically advanced and/or less digitalised (Boot et al., 2020).

In the future, existing and new technologies in the financial sector will almost certainly become more varied and widespread. Data has become the *real* key asset for companies in the provision of any services, including financial and banking products and services. For financial intermediaries, IT systems will have to be centred on data and their accessibility and interoperability for all the various functions of each company (Sperimborgo, 2016). This will also require banks to keep on acquiring new competencies and skills built around innovation technologies, in order to compete effectively with other emergent players (i.e., BigTech firms).

[22] A TechFin is a firm who leverages existing technology solutions to provides financial products and services.

As this book explores further in subsequent chapters, banks are at the gateway of a new era of data collection, treatment and analysis that will rely on advanced innovative techniques—many yet to be developed. For example, deep learning (a particular branch of machine learning that uses algorithms inspired by the way the human brain works) is gaining increasing prominence in many fields, such as trading, asset management, risk management, credit underwriting, but also fraud detection, cybersecurity and AML applications. The new applications and methodologies will also require rethink of regulatory frameworks designed to promote level playing fields. In particular, regarding how best to enabling banks to leverage and access the most advanced technologies[23] without loopholes in the overall regulatory schemes that may allow regulatory arbitrage in this field. Explainability, fairness and avoidance of potential biases in algorithm must be ensured by the regulation as these factors can affect market stability (Gensler & Bailey, 2020). Risk management employing deep learning methodologies (or other AI tools) will have to consider both micro and macro-prudential risks, also tackling systemic risk in—more than ever—in interconnected financial markets. In this setting, unregulated entities also will gain importance (such as BigTech) in the provision of technological services and this poses further questions for policymakers and supervisors that must be faced through coordinated and harmonised supranational responses.

As a result of these expected developments, the players in the financial markets will change, with some traditional banks failing to renew their business models and some FinTech companies not surviving the market. Estimates suggest that 20–40% of banks will disappear in Europe in the next 10 years (DNB, 2020). However, surviving players will most likely include BigTech companies. Ultimately, the financial intermediaries and FinTech companies who flourish will be those who prove capable of grasping the opportunities of digitalisation while controlling and correctly managing risks, while also finding optimal balances between partnerships, investments and internal development.

The supply of financial services and products will become more digitalised. This will hold for basic products like personal loans, short-term loans for firms through invoice trading, robo-advisory services for small

[23] Some banks and financial intermediaries are indeed now excluded from the use of alternative innovative data analysis tools, such as some artificial intelligence applications that work as black box (Giudici & Raffinetti, 2020).

wealth. The supply will mainly occur though digital channels without the intervention of physical consultants. Additionally, a possible increased standardisation will probably result in an intense competition on the price of the services. Other services that are considered high-value-added services, including financial advice for High-Net-Worth Individuals and/or financial advisory and risk management services for (large) companies will also be offered through digital channels or using technologically advanced solutions, but are more likely to still envisage the presence of a human consultant to deal with more complex issues (Gomber et al., 2018). In both cases, level of digitalisation will be high. Again, COVID-19 represented a no-turning back point for digitalisation and a boost (especially, but not only) in the rethinking of channels and offer strategies by industry players.

In the front-office, customers now expect to be able to access banking services anytime from any location, with any internet connected devices. In the middle- and back-office banks will have to be prepared to invest and implement the most advanced technological innovation in areas including data management and processing, risk estimation and internal validation of procedures. Undoubtedly this will require banks to keep on making consistent investments in technological development and will put pressure on profitability and costs. Additionally, banks will increasingly have to rely on some of the key services offered by BigTechs and other institutions, such as cloud computing, data management and AI applications.

In payments, development and standardisation will continue. The importance of alternative payments further increased during the COVID-19 pandemic, especially in advanced economies (BIS, 2020; Capgemini, 2020). These alternatives include online payment services and digital wallets. More generally, technological solutions contributed to the development of new payments systems, with QR code, mobile POS and online POS facilitating the spread of alternative payments forms (CCAF, World Bank and World Economic Forum, 2020). Other solutions that also apply to the payment sector include anti-fraud systems and cybersecurity features, biometric recognition of clients and the diffusion of NCF technologies.[24]

[24] As reported by Ratecka (2020) and Getsmarter (2018) the Chinese BigTech Alibaba introduced in 2017 a tool "Smile" that allowed to pay making a smile to the camera.

Improved technological solutions will enable an even more flawless and secure experience, thanks also to facial recognition devices, and improved fraud detection made possible by AI and natural language programming systems. Despite the, no doubt, strong and increasing competition exerted by FinTech and BigTech companies in this area, banks will probably retain at least in part a share of the business. Despite the limited profit potential financial intermediaries can obtain through these services, payment accounts represent an opportunity to sell other services and products related to savings and mortgages, for instance (DNB, 2020) the key to the survival and existence of banks.

With reference to cryptocurrencies, interest in these instruments has also recently emerged from central banks planning to issue central bank digital currencies (CBDCs) to grasp the possible benefits of virtual currencies, including in helping meeting goals for financial inclusion. As highlighted by a report by the Committee on Payments Markets Infrastructures (CPMI, 2018), central banks can develop digital currencies different ways, for example, making it accessible by the general public or only by identified institutions. The wholesale use of CBDCs on DLT technology could generate a more efficient system for payments and settlement of market and derivatives transactions. While, the benefits of developing CBDC at the retail level, on the other hand, maybe more limited given the existence of an already relatively efficient payments system. It is also generally thought not appropriate for CBDCs to follow the example of existing cryptocurrencies in ensuring the anonymity of transactions, as it cannot be excluded that CBDCs could be used for illicit purposes. The specific model adopted could lead to differences as to who oversees KYC (know-your-customer) verification and related AML duties. The use of non-anonymous CBDCs, on the other hand, could contribute to a very efficient AML system. The desirability of creating a CBDC in one jurisdiction must also consider potential indirect effects, including effects on bank deposits (which could suffer outflows due to the digital currency alternative), in other jurisdictions and more general financial stability effects (CPMI, 2018; PWC, 2020). To date, some authorities have taken an interest in the topic and launched feasibility studies, such as the People's Bank of China, European Central Bank, the Bank of Canada and the Bank of England, although central bank virtual currencies have so far seen little development (Duong, 2020).

Central bank digital currencies will hence probably also enter the market, although their level of diffusion going forward is hard to estimate

(BIS, 2020). To date, not all central banks are actually entitled to issue digital currencies to the public, and regulation will have to be modified if this path is about to be followed (Bossu et al., 2020).

For more detailed discussion of digital currencies, we refer the interested reader directly to Chapter 4 of this book.

In the insurance sector, technological applications will continue to modify the way insurance companies interact with their customers; for example, through the enriching of data and information exchange, which should allow firms to better monitor and estimate risks. The digitalisation of channels will also have an important role in cultivating strong relationships with clients. It is not feasible for insurance companies to adopt a commercial strategy that only involves physical contact after the COVID-19 experience, and already it is widely understood that digital channels can be quite effective especially for the most standardised types of insurance policies (e.g., vehicles). Innovations will stem from interactions between incumbents and InsurTech start-ups and, with this, BigTechs might also increasingly enter the market and provide insurance products (Cappiello, 2020). Additionally, in InsurTech, the new business models introduced with FinTech can affect the design and the pricing of insurance policies that influence the response to customer needs. New types of policies are designed and developed to include new or emerging types of risks, such as cyber risk, catastrophic insurances or business continuity risks (Cappiello, 2020). These will leverage the pool of big data, the data analytics and the most advanced estimation techniques.

In conclusion, Phase 4 will be both the result of what has been achieved over the last decades, as well as future innovations and inventions yet to be developed on the back of significant events like COVID-19, that put banks and other financial players under strong pressure (from many perspectives). Today (2021) digitalisation has become the "new normal" for customers and changes in business models cannot be further postponed. Nevertheless, additional important challenges will lie ahead and must be addressed. Digitalisation will have to be developed in synergy with another dominant topic of the research and policy agenda for the next years: sustainable, green, and more inclusive societies. Since the Sustainable Development Goals set by the UN in 2015, more awareness has been raised on the necessity of a transition to more sustainable and inclusive societies. With this, national and international policymakers have emphasised the importance of meeting these challenges within the banking and financial sector,[25] also through digitalisation.[26]

Finally, when evaluating future developments, we should keep in mind a lesson from the recent past, which is that digital transformation must not be interpreted only in terms of cost savings, but also as the necessary way to cope with competition from new players that list technology development as one of their core business goals and use data as a competitive advantage. Technology will become even more of an essential tool in the banking and financial sector landscape and keeping pace with technological change (and consumer preferences) will be the only way to survive the industry transformation. Since data is the key asset in banking and financial services, successful digital transformation will only be feasible in a cooperative environment, where banks, BigTech and FinTech companies act both as competitors (for the final service) and as partners (in the innovation process). Finally, but no less importantly, regulation will also have to evolve to contribute to a more level playing field and to enable banks to access the most advanced technologies, as well as addressing key challenges such as systemic risks generated by new entrants (BigTechs and FinTechs) and the management of new types of risks determined by the most advanced technologies (e.g., AI, DLT, ML). The way forward of course is not to lower the standards of regulation, but to find solutions that can complement the objectives of regulation with a more efficient, responsive, safer and agile financial system. A more articulated financial system must rethink the perimeter of regulations, the relevant authority system and the innovation in the regulated phenomenon. The approach "new functionality, new rule" to individuate potential uncovered risks must be implemented at international level to proceed towards a more effective regulation and supervision of innovation in the banking and financial system (Amstad, 2019; Perrazzelli, 2021). And to promote the level playing field between newcomers and incumbents.

[25] See, among others, European Commission (2018) and the European Green Deal (European Commission, 2019), Nassiry (2018), Macchiavello and Siri (2020).

[26] As an example, the "G20 TechSprint" initiative, promoted in May 2021 by the G20 and the Innovation Hub of the Bank for International Settlements that will encourage private sector companies to develop innovative technological solutions to tackle the priorities set, including cyber security, open finance, green finance, SupTech and RegTech, next-generation financial market infrastructures (FMIs) and Central bank digital currencies (BIS, 2021).

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CHAPTER 3

A Taxonomy of FinTech Innovation

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3.1 Part 1: Introduction to Innovation

3.1.1 Innovation as a Driving Force of Economic Growth

Economists have long identified in innovation the driving force of economic change. In a contested marketplace where rival firms compete neck and neck for consumers' preferences, it is through innovating, or, in the words of Schumpeter (1939), by '*doing things differently in the realm of economic life*', that firms can gain an edge over their competitors.

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Central to Schumpeter's theory of innovation is the notion of '*new combinations*'. As well noted by Hagedoorn (1996), such new combinations can capture the introduction of a new product or a novel variety of an existing product, a new production technology or function, developing new supply sources or implementing a new organization structure within an industry. In other words, innovations emerge when new combinations of knowledge, technologies and inputs lead to the successful introduction of new products and processes.

Schumpeter (1939) relies on the notion of a 'circular flow' to explain how innovations drive economic change. In examining Schumpeter's theory, Hagedoorn (1996) notes that such circular flow represents a stationary situation of equilibrium, where firms continuously adapt to small external changes and absorb such changes into their operational routines. Mostly through new disruptive innovative practices, products and processes, the economic system is perturbed and driven away from the existing neighbourhood of equilibrium. In sum, the dynamics of economic change emerge from repeated and interactive cycles of innovations.

While it is indisputable that innovation significantly shapes economic change, and therefore, economic growth, how the process of innovation occurs inside firms has been the subject of active debate in the growth economics literature. Verspagen (2005) contends that, initially, growth models, such as the model by Solow (1956), assumed that technological change was considered to be a force exogenous to firms. However, since in the real world it is well known that most of the innovations are developed within firms, the model's assumptions are often viewed as unrealistic. In contrast, *endogenous growth* models appeared later on in the literature, mostly led by the works of Romer (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992), placing the firm as main actor in the innovation process and hence as a major promoter

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of economic growth, by modelling the R&D (research and development) process as an internal investment decision within firms. As summarized by Verspagen (2005), most of endogenous growth models conceptualize R&D as a lottery in which the prize is an innovation. Every time a firm successfully innovates, it gains an edge over rivals (such as temporary monopoly power, or privileged access to a new variety of capital). Such models typically assume that the expected benefits and costs of R&D are known with weak uncertainty, with firms making a cost–benefit analysis as to determine the optimal level of investment in R&D, which in turn determines the rate of endogenous growth enjoyed by the investing firm.

As well observed by Kogan et al. (2017), the theory of endogenous growth models provided economists with a vast array of empirically testable propositions, equally at the aggregate (macro) and at the firm (cross-sectional) levels. Such predictions draw a close linkage between improvements in the technological frontier, how optimally resources are allocated by economic agents and firms, and ultimately, how fast economies grow as a result of cycles of innovations.

At the firm level, several studies examine whether and how innovation affects productivity levels. For instance, Griffith et al. (2006) estimate a structural model linking R&D expenditures, innovation outputs and firm productivity. Their findings show that larger companies, firms exposed to international competition, and firms receiving government support are all more likely to make R&D investments. Furthermore, the authors show that, in several countries, innovation is associated to higher labour productivity. Further testing shows that product innovation affects productivity in a larger number of countries when compared to process innovation. For instance, the estimates reported by the authors suggest that product innovation can account for an 18% gain in productivity in Spain and for about 6% increase in productivity in both France and the UK, while having no significant effect whatsoever in Germany. Studying six Latin-American economies, Crespi and Zuniga (2012) find that firms investing in knowledge are better able to introduce new technologies, whereas firms that innovate have higher labour productivity compared to firms that do not innovate.

Examining 17 industries in OECD economies, Ulku (2007) shows that the rate of innovation within an industry exerts a positive effect on the growth rate of output. On the other hand, Demirel and Mazzucato (2012) contend that the extent to which innovation affects firm growth depends on several characteristics of innovative firms. For instance, they show that the positive effect of innovation (measured as R&D) on growth is conditional on firm size and on the persistence in patenting, whereas in small firms, only firms that persistently file patents for a minimum of 5 years manage to enjoy the benefits of innovation in terms of growth.

At the aggregate level, a voluminous literature has examined the theoretical prediction that innovation by firms leads to economic growth. Stokey (1995) notes that innovation in products and processes is a major force explaining economic growth in developed economies. Employing patents as a proxy for innovation, Blind and Jungmittag (2008) show that innovation contributes significantly to economic growth in Europe. Likewise, Inekwe (2015) reports a beneficial effect of R&D spending on economic growth in several developing countries, especially in middle-income economies. Examining a global sample of 58 countries, Hasan and Tucci (2010) show that countries hosting firms with higher quality patents post higher economic growth. In sum, empirical evidence tends to, in general, corroborate the innovation-growth nexus, conferring a central role for innovation in economic analysis.

3.1.2 Innovations in the Finance Industry

While the role of technological innovations has received substantial attention in the economics literature, financial innovations are equally important and exert beneficial effects too. Technological and financial innovations both respond to economic incentives. The economic incentives spurring financial innovation are typically related to the regulatory environment and also to financial market conditions. From the perspective of regulation, financial innovations often emerge as solutions to circumvent regulatory constraints. From the perspective of the market, new financial instruments and practices are innovated as to mitigate the impact of financial constraints on firms and on consumers.

Just like technological innovation, financial innovation also improves economic welfare, although the channels through which these two types of innovations operate might differ. As we discussed in the previous section, technological innovation improves economic growth and income levels by pushing the productivity frontier and therefore output levels upwards. Silber (1983) argues that innovations in financial institutions and their products and practices contribute significantly in improving the ability of firms and consumers to bear and diversify risks (such as developments in futures markets), in reducing transaction costs (like improvements in payment methods), and in circumventing outdated regulations of several forms. As the author concludes, financial innovations produce economic benefits of similar importance in terms of economic welfare gains than innovations in technology and production.

Tufano (2003) refers to financial innovation as the creation, popularization and diffusion of new financial instruments, technologies, institutions and markets. Innovations in the finance industry can materialize in new products and processes, although the boundaries of these two types of advancements can be blurred at times. For example, product innovations include new derivative contracts, new corporate securities or new forms of pooled investment products, whereas process innovations encompass improvements such as new means of distributing securities, processing and pricing transactions. But as the aforementioned author points out, such differentiation between product and process innovation can be innocuous and unclear, as improvements in both fronts are often intimately linked with one another. Financial innovations emerge as to provide solutions to several market imperfections, like asymmetry of information and imperfect risk-sharing, which prevent financial market participants from obtaining the functions they require from the financial market. The functions of the financial system that can be improved by financial innovations include moving funds efficiently across time and space, pooling funds, risk management, improving information availability, mitigating asymmetry of information between parties and facilitating the transaction of goods and services through a more efficient payments system (Merton, 1992; Tufano, 2003).

The economic incentives to produce financial and technological innovations tend to interact with one another. For instance, Laeven et al. (2015) develop an endogenous growth model of financial innovations in which financiers' decision to innovate are strongly linked with the production technological frontier. They model both financial and technological innovations as to reflect profit maximizing decisions of financiers and entrepreneurs. Technological entrepreneurs invest in risky innovations, but the extent to which innovations are profitable carries uncertainty. Financial innovations are useful as they allow for improved screening of profitable production technologies, which in turn makes investment selection more informationally efficient. Hence, financiers decide optimally on how much to invest in financial innovations, balancing the costs and risks involved with this investment against the temporary monopoly rents generated by the innovation, which enables financiers to screen investments by technological entrepreneurs more efficiently than their competitors.

Importantly, a central feature of this model is that as technology evolves, each screening modality innovated by financiers becomes obsolete in identifying promising technological entrepreneurs because informational asymmetries widen as technology evolves. A direct consequence from this property is that financial and technological innovations are positively correlated, and crucially, unless financiers continuously innovate as to efficiently screen technological entrepreneurs, technological progress stalls and economic growth stagnates. Therefore, such mutual interdependence between technological and financial innovation confers a central role for financial innovations in boosting sustainable economic growth.

As argued by Schiller (2013), finance begets and supports mostly all sorts of economic activities permeating societal life, thus innovation is necessary to preserve finance's role in promoting a dynamic economic system and as means to achieve societal goals more broadly. Empirical evidence tends to corroborate the prediction that financial innovation spurs economic growth. For example, studying a cross-country sample, Beck et al. (2016) find that financial innovation is associated to a faster growth in the banking sector, and to higher economic growth in countries and industries enjoying valuable growth options. Adding to the benefits of financial innovations, Dynan et al. (2006) show that financial innovations can contribute towards lowering the volatility of real economic variables like consumer spending, housing investment and business fixed capital investments. In sum, finance greases the wheels of economic growth, and as technologies evolve, finance must evolve too, through innovations.

3.1.3 The Emergence of FinTech

In recent years, the word 'FinTech' has featured heavily in public discourse concerning the future of finance and banking. More succinctly, it is very much the topic *du jour* in finance (Thakor, 2020). Building on Tufano's (2003) earlier mentioned definition of financial innovation, we refer to financial technology broadly as 'any technology that enhances the provision of financial services' which '…ultimately consists of the set of recently developed digital technologies that have been applied – or that will likely be applied in the future – to financial services' (Chen et al., 2019). Much emphasis has been placed on the role of specific FinTech innovations on the future direction of banking and financial services, with the recently published independent *Kalifa Review* of UK FinTech asserting that 'FinTech is not a niche within financial services. Nor is it a sub-sector. It is a permanent, technological revolution that is changing the way we do finance' (Kalifa, 2021, p. 2). Though innovation is present at all times and in all industries, the speed with which technological innovation is taking place in the finance sector in particular, relative to both historical precedent and other industries, has caused financial institutions to invest heavily in the area for fear of being left behind. A survey by *PriceWaterhouseCooper* found that 81% of banking CEOs are concerned about the speed of technological change, which is considerably more than any other industry sector (PWC, 2020).

Although the origins of the word FinTech date back to the 1980s, and arguably earlier, Google Ngram Viewer[1] primarily documents a notable increase in usage from 2008 before a rapid rise in public discourse from 2011 onwards. Thus, the recent FinTech era is considered to have emerged in the aftermath of the global financial crisis, which is perhaps no surprising given the resulting lack of trust in the traditional financial system. 'FinTech innovation' encompasses a wide range of innovations across a spectrum of financial services. Significant emphasis is placed on peer-to-peer systems, enabled using blockchain technologies, which allow for the potential disintermediation of financial services and thus can potentially drive down the associated costs of financial transaction. However, FinTech innovation also incorporates (but is not limited to) developments in lending and financing, mobile payments, financial management, insurance, markets and exchanges (Das, 2019). An overview of the many individual innovations driving FinTech growth is too comprehensive for this chapter. Instead, the important thing to note is that, as mentioned earlier in this chapter, financial innovation per se is not recent, and has always played an instrumental role in the development of the financial markets, structures and systems that we interact with today. The speed with which the banking industry evolved may not have historically matched the rate of digitalization across other industries until recently, but it has evolved nonetheless.

From the introduction of personal credit cards to electronic trading on financial exchanges, innovation has shaped the way in which we save,

[1] Google Ngram Viewer is an online search engine which, at the time of writing, plots the annual frequencies with which strings of characters are found in Google's text corpora between 1500 and 2019: https://books.google.com/ngrams/graph?content=FinTech.

trade, invest and spend. As an example, a steep decline in the number of UK bank and building society branches occurred over little more than three decades, from 21,643 in 1986 to 10,405 in 2019 (Rhodes, 2020)[2]; a result of an increase in the number of Automated Teller Machines (ATMs).[3] In more recent years, however, the number of ATM machines and transactions has declined as a result of the rising popularity of cashless payments.[4] Moreover, cash will arguably no longer king both during and following the Covid-19 pandemic, which has only served to intensify the rate of change.

As such, the banking sector—including retail, commercial and investment banking—exists in a constant state of technological change, perhaps now more so than ever. Adapting to the latest wave of innovation, in particular, has been challenging for banks given their organizational inadaptability, legacy main banking systems (in some cases dating back to the 1970s), and more stringent regulations (Guibaud, 2016). However, adapting to new innovations is essential for legacy banks given the external pressures introduced by the rapidly growing number of competing FinTech firms. According to the Department for International Trade (2019), there are now over 1600 FinTech firms in the UK alone. These FinTechs have been building new business models, such as automated investment services, that compete fiercely with established banking operations (Sironi, 2016). The resulting competition ultimately presents challenges to existing players in banking systems, but also considerable opportunities.

Aside from the rate of technological change taking place in financial services, why has so much emphasis in the banking sector been placed on FinTech innovation? Certainly, industry places a great deal of importance on FinTech innovations, given that the considerable level of worldwide investment in FinTech continues to grow; global annual investment increased 14% in 2020 to $44 billion (Innovate Finance, 2021).

[2] It should be noted that the 1986 figure here is based on data from the British Bankers' Association (BBA), whereas the 2019 data is from the Office of National Statistics (ONS).

[3] The number of LINK ATM machines (an interbank network of ATM machines that accounts for virtually all cash machines in the United Kingdom) increased from 24,574 in 1998 to 70,588 in 2015 (LINK, 2021).

[4] In Europe, for example the number of ATM machines decreased declined by almost fourteen thousand between 2016 and 2018 (De Best, 2021). https://www.statista.com/statistics/445076/transactions-at-atms-in-link-network-in-the-united-kingdom/.

Ultimately and unsurprisingly, a key motivator lies in firm performance, or 'the bottom line'. Evidence suggests that the median private value of a FinTech innovation is approximately $46.7 million, compared to a median value of $3.1 million for other financial innovations (Chen et al., 2019). Breaking this down beyond the bottom line, potential benefits increased customer retention, fraud detection, automation of financial analysis and lending, and the ability to target new clients (Das, 2019).

Aside from incumbent banks and institutions, FinTech innovations also pose opportunities (and threats) to government entities, regulators and individual spenders, savers and borrowers globally. A comprehensive overview of individual innovations lies outside of the scope of this chapter, and so the remainder of this chapter will focus on two key technological developments; one that has given rise to a number of FinTech innovations across financial services, which have significant impact on some (or indeed all) of the above-mentioned stakeholders, and another which has the potential to do so in future. The first is the emergence and maturation of open banking in response to recently enacted EU legislation. The second refers to the ongoing conceptualization and development of central bank digital currencies (CBDCs).

The revised Payment Services Directive (PSD2), adopted by the European Parliament, fundamentally changed the banking industry. Specifically, this regulatory change gave rise to Open Banking,[5] which enables customers to consent to third parties accessing their payment account information, or making payments on their behalf (Financial Conduct Authority, 2021). In other words, whereas financial institutions would previously hold and manage customers' information, personal information can now be shared among financial institutions and third-party FinTech firms. Designed to stimulate competition in banking sector, it has sparked new innovations that can offer users more bespoke, personalized tailored financial service products (Open Banking, 2020).[6] Innovation in this respect has been primarily driven by new start-up FinTech firms

[5] The Open Banking initiative in the UK also resulted from the outcome of an investigation into the retail banking market by the Competition and Markets Authority (CMA) (UK Government, 2021).

[6] As a result of this, consumers may be better able to switch to banking accounts and services that improve their financial wellbeing. For example, in a CMA survey conducted by GfK NOP (2015), 8% of respondents claimed to have switched providers within the last three years, compared to 45% for car insurance and 31% for energy.

and challenger banks. For example, the open banking platform has led to the development of services that provide account aggregation services, personal finance advice, accountancy and credit rating services, personal finance advice, accountancy, credit rating services and charitable donations.

Broadly speaking, the ability for FinTechs to leverage the vast amount of transactional data generated each day from registered customers can lead to the development of tools designed to increase client's financial wellbeing. Initial demand for the service has been strong. In the three years since open banking commenced in the UK and across Europe, the ecosystem had grown considerably,[7] with 178 firms permitted to share bank account and payment innovation with third parties in October 2020 (Chatenay, 2021),[8] and that number grew further to 300 by 2021, with 2.5 million UK consumers and businesses (Open Banking, 2021).

However, there are considerable challenges that must be considered before the widespread adoption of open banking is realized. Namely, a lack of awareness and transparency has led to a majority of business owners signalling reluctance to share bank data electronically. A survey conducted by the Federation of Small Businesses (2020) identifies that 65% of small firms would not consider sharing their banking data with other financial service providers electronically, and 43% believe that sharing banking data in this way is unsafe. Further, there are criticisms that open banking does not offer a level playing field, and is strongly in favour of FinTechs rather than legacy banks, with ING Chief Executive Steven van Rijswijk noting that 'they get access to our customers' data, and at the same time, they can use their own data as well which they get from customers'.

CBDCs are gaining increased traction among central banks in recent years, and holds implications for anyone that holds currency issued by a central bank. In other words, a majority of the world's population. In straightforward terms, a CBDC effectively refers to a 'digital banknote' (Bank for International Settlements, 2021). As well as a means of payment, however, it can also pay interest and does not necessarily need to be held within a commercial bank (Carapella & Flemming, 2020).

[7] Although not as quickly as.

[8] Comparatively, the number of firms engaged in the Open banking ecosystem across Europe is lagging. As of October 2020, there were 36 such firms in Germany, 18 in France, 9 in Spain and 6 in Italy (Chatenay, 2021).

Understandably, they have generated a considerable amount of debate and excitement even though they are yet to be implemented. Currently, 80% of central banks are engaged in investigating the viability of CDBCs, with 50% having progressed to a development or pilot phase (Boar et al., 2020). A primary driver of harnessing this innovation is that digital fiat currency can offer an attractive alternative to cash fiat currency, in that it can (i) potentially overcome the counterfeiting issue associated with cash, and (ii) allow for higher levels of inclusivity, by accessing those that have previously been excluded from typical banking services. Thus, 'unbanked' individuals are able to access a new array of financial resources, while traditional and challenger banks are able to access an untapped client base. There has also been some discussion about the use of 'controllable anonymity' in digital currencies; an apparent contradiction in terms used to describe payments that would be anonymous only to a certain extent, and thus would allow for data analysis that could also help central banks to identify illegal activities.

Despite the excitement surrounding digital currencies, there are some potential concerns stemming from the adoption of digital currencies. As a means of payment that can pay interest and thus does not necessarily need to be held in a commercial bank, what will it mean for deposit rates and the provision of loans? Concerns exist that CBDC's may remove a key funding source for commercial banks, which may impact upon the amount of lending activity that such institutions engage in (Carapella & Flemming, 2020). Thus, as with FinTech innovations generally, their introduction presents opportunities for some, and threats to others. Despite this, there is obviously some optimism and excitement of the role that this particular innovation could play in the future: China has already launched testing of its digital through a number of its state-owned banking institutions, while Sweden's *Riksbank* has moved to the next stage of pilot-testing payment, deposit and transfer capabilities for a digital 'e-krona' (Armelius et al., 2020).

There are a number of other crucial technological developments that have led to a number of new products and services in financial services, and will continue to in future. However, perhaps no innovation has caused so much public excitement and speculation in recent years as the blockchain. Indeed, in events reminiscent of the 'dot-com' bubble at the turn of the millennium, companies changing their name to include the word 'blockchain' saw significant increases in their share price for two months thereafter (Jain & Jain, 2019). For example, *Long Island Ice Tea* changed its name to *Long Blockchain Corp.* and shares subsequently rose by over two hundred per cent (Cheung, 2017). A large proportion of banks' revenues originate from their role as an intermediary.

Blockchain threatens to significantly disrupt the intermediary business model by maintaining integrity in peer-to-peer systems that can potentially disintermediate many financial services (Drescher, 2017). As such, the financial services industry is estimated to be spending approximately $1.7 billion per year on blockchain (Greenwich Associates, 2018). The technology has, to some extent, been a victim of its early hype, with commentators identifying 'blockchain fatigue' and noting that 'a real breakthrough in applications is missing so far' (Kelly, 2019). But there is good reason to believe that, with time, blockchain may play a disruptive role in financial services.

From this chapter, it is evident that the recent introduction of a number of FinTech innovations is changing the financial services industry at a speed with which banking institutions are unfamiliar. The level of investment and subsequent disruption across the various FinTech domains present opportunities and threats to banks, both commercial and central. Finally, we must ask, what can a country do to ensure that it remains at the forefront of FinTech innovation, and thus attracts significant investment from private enterprise? Broadly speaking, it should foster and enable the development of a growing national FinTech ecosystem. The foundations of an economic and regulatory framework that supports growth are imperative, as Kalifa (2021) notes in his review of UK FinTech: 'it is about building markets for this innovation to grow into. A great product will not succeed without a strong customer base, adequate regulation, and access to data, skills and capital'.

3.2 Part 2: A Taxonomy of FinTech Innovation Based on Patents

3.2.1 Identifying Key Areas of Innovation Using Patent Data

There is significant and ongoing disruption in the financial sector with innovative FinTech start-ups including FinTech unicorns posing new challenges to existing banking and financial institutions. In some cases, market shares in key areas are being eroded.

From Fig. 3.1 we identify four categories of FinTech that are attracting the most innovation based on the number of worldwide patents applications filed with the United States Patent Office USPTO, which we employ as a barometer to assess the most important FinTech areas. Specifically, we identify in (1) payments channels (2) banking channels, (3) financial services, and (8) Reporting and Analytics four clear broad areas of innovation. Table 3.1 shows how these broad areas of patent innovation map to more granular areas of FinTech innovation activity.

In the remainder of this chapter we provide a broad review of each of these four areas of FinTech innovation (i.e. *payments Channels*, *banking*

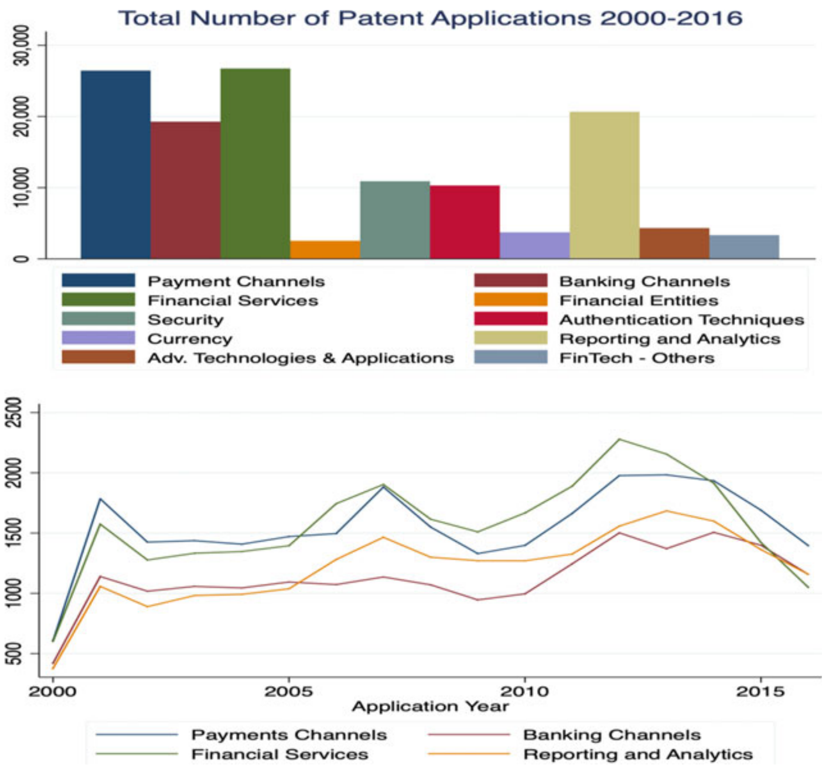

Fig. 3.1 Identification of major categories of FinTech innovation (*Source* Created by authors based on USPTO data and Clarivate FinTech Patent taxonomies)

Table 3.1 Categories of FinTech innovation based on patents

FinTech category	*FinTech taxonomy level 1*	*FinTech taxonomy level 2*
1	Payment Channels	Cheques/Drafts
		Electronic Fund Transfer
		Credit/Debit Cards
		Contactless payments
		P2P payments
2	Banking Channels	Cash Dispensing Machines
		Internet/Mobile Banking
		Digital Wallets
		POS Terminals
3	Financial Services	Loans and Interest
		Trading, Stocks and FE
		Insurance and Pension
		Auctions
		Rewards/Loyalty Points
		P2P Loans
		Real-time Payments
		Real-time Loan Processing
		Microtransactions
		Revenue Models
4	Financial Entities	Clearing House
		Payment Gateway
5	Security	Fraud Detection
		Alerts and Notifications
		Tokenization/Token-based
		Cryptography
		Secure Element
		Host Card Emulation (HCE)
		Trusted Execution Environment (TEE)
		Virtual Keyboards
		Blockchain/Distributed Ledger
		PCIDSS
6	Authentication Techniques	Passwords
		Knowledge-based Authentication
		Single Sign-on (SSO)

(continued)

Table 3.1 (continued)

FinTech category	*FinTech taxonomy level 1*	*FinTech taxonomy level 2*
		Biometrics (Touch ID/Face ID)
		Multi-factor Authentication
		Device-based Authentication
7	Currency	Digital Currency
		Crypto Currency
8	Reporting and Analytics	Data Analytics and Business Intelligence
		Wealth Management
		Debt Management
		Risk Management
		Big Data
		Credit Scores
9	Advanced Technologies and Applications	AI based Recommendations
		Chatbots and Personal Assistants
		Cloud Computing
		Internet of Things
		Wearables for Payments
		Virtual/Augmented Reality Payments
		Banking APIs
		Embedded Commerce
10	FinTech - Others	Anything not covered by other categories

Source Created by authors based on USPTO data and Clarivate FinTech Patent taxonomies

channels, *financial services*, and *Reporting and Analytics*) including at FinTech Taxonomy Level 2.

3.2.1.1 Payments Channels

The first major area of innovation identified from our comprehensive data on worldwide patents filed with USPTO is in the area of **payments channels**. Within this category there has been particularly strong growth in the area of digital payments. However, there has also been significant development in more traditional payment methods such as cheques despite their decline in popularity in countries such as the United Kingdom (UK).

In the remainder of this section we offer a brief review of each of the detailed areas of *payments channel* innovation as detailed under

Table 3.2 Comparison of cheques and demand drafts

	Cheque	*Demand Draft*
Definition	Represents an instruction to a bank by a customer to pay a specified sum to a named person	A pre-paid negotiable instrument issued by a bank, that allows the holder (a bank customer) to transfer money to a payee
Order of payment	From the account holder to the bank	From one bank branch to the same or another branch
Payment	Either to order or bearer	On demand to a named party
Issuance	Bank customer	The bank
Banks charge for issuance?	No	Yes
Drawer	Bank customer	The bank
Signature	Bank customer	The bank
Dishonour possible?	Yes	No

Source Compiled by authors

the heading 'FinTech Taxonomy Level 2' in Table 3.1. In order of presentation, these are: *Cheques/Draft*, which includes payments via cheques/drafts—including security, authentication, clearing of cheques and drafts; *Electronic Fund Transfer*, covering the electronic transfer of money (e.g., bank-to-bank, consumer-to-merchant, P2P); *Credit/Debit Cards*, payments and fund transfers by credit and debit cards; *Contactless Payments*, digital and contactless (minimal or no contact based) payments by mobile devices and instruments, such as QR code/NFC/RFID based payments; and *P2P payments*, covering peer-to-peer (P2P) payments including but not limited to social network payments, crowd funding, etc.

Cheques/Drafts

Although cheques and drafts are similar there are some key differences. Most pertinently, while cheques are issued by bank customers' and require the signature of the account holders, bankers' drafts or 'demand drafts' are prepaid, issued by banks and require no signature. The following table provides a more detailed comparison between cheques and drafts (Table 3.2).

Usage of cheques and drafts has been in sharp decline in most economies as faster and more efficient alternative electronic payment methods have grown rapidly in prominence. For instance, in 2020 The Payments Association of South Africa (PASA, which represents the largest banks in South Africa, predicted the discontinuation of cheques in the country, commenting that '*The usage of cheques has rapidly declined over the last decade, with very few consumers, public and business entities presently making use of this payment method*…[and that the]… *payment method is also significantly less effective than any of the digital payment methods available today*' (FinTech Futures, 2020). Similarly, In the UK the number of cheques written declined from 1213 million in 2009 to 272 million in 2019.

Yet despite the fact that cheques and drafts have become increasingly scarce in their use they are still relied on by a small portion of consumers and still used quite frequently for business to business transactions especially in the case of small businesses. In terms of innovation, although the cheques and drafts sub-category within *Payments channels* represents only a small portion of filed patent applications, there has still been notable innovation in this area. This activity seems to be mainly focused on issues of efficiency and fraud prevention. The greater efficiency and convenience of other forms of payments, as well as regulatory changes are likely drivers of such innovations. For example, with respect to the latter point, countries such as the U.S. have introduced tougher regulations that have put greater onus on banking institutions to take responsibility, and to bear the costs of, fraudulent cheques cashed.

Specific innovations have included cheque truncation and cheque imaging systems, which relate to the digitalization of physical paper cheques into electronic forms, which are then transmitted electronically, and as such remove the requirements for physical checks to be moved across the banking system. Such systems are increasingly becoming the norm and have helped improved the efficiency of cheque processing with boosts to speed and mitigated potential issues with lost cheques in the banking system and other logistical problems. Such innovations have also helped alleviate security concerns surrounding the physical movement of cheques and clearing related frauds. For example, in the UK the Image Clearing System (ICS), which was introduced in 2017 by the Cheque and Credit Clearing Company, has led to faster clearing of cheques. It has also allowed for the use of mobile phones, equipped with cameras combined with banking apps, to process cheques rather than requiring customers to visit bank branches. Similarly, other countries such as India have also introduced this ICS technology.

Electronic Fund Transfer

Electronic fund transfer (EFT) is a process of direct digital money transfer between two bank accounts without the direct intervention of bank staff. Transfer of funds is initiated by a sender who sends a request to their bank, either through the IoT or at a payment terminal, using electronic funds transfer at point of sale (EFTPOS). EFT is a broad category, which includes various electronic money transfers that involve computers and which do not require human intervention, such as automatic teller machines (ATMs), payroll direct debits, wire transfers, debit and credit cards, electronic checks, mobile wallets, electronic tax payment systems such as the Electronic Federal Tax Payment System (EFTPS) provided by the U.S. Department of the Treasury, and digital banking.

EFT has a rich history that surprisingly goes back as far as 1871 when Western Union introduced the idea. Key innovations such as the introduction of the first credit cards in the 1950s as well as ATMs led to increased popularity in EFT. Yet it was not arguably until 1972 when the Federal Reserve Bank of San Francisco established a paperless transfer system did EFT begin to transform the nature of money transfer. Subsequently the invention of the IoT has accelerated the growth in use of EFT, although the percentage of total transactions is still quite low with EFTs accounting for only 9 per cent of all worldwide e-commerce transaction volumes according to data from Statistica with much of this activity centred in Europe. More broadly, recent data from the U.S. Federal Reserve's 'Diary of Consumer Payment Choice' reveals that 'electronic payments',[9] represent about 11 per cent of total payments.

Recent EFT innovation activity has focused on security, information transfer and efficiency in the area of international money transfers—all of which are increasingly important for businesses. Indeed, an increasing number of businesses have operations in multiple countries and there is a need for fast, efficient, secure and low-cost international monetary transfers. Similarly, labour markets are increasingly global meaning that employees may work in foreign countries during their careers either temporarily or permanently and similarly require such efficient EFTs to

[9] The Federal Reserve define electronic payments as being bank account number payments, online banking bill pay and payment services such as PayPal.

send money overseas to families and friends located overseas. Important areas of development include immediate funds transfers (IFTs) and real-time payments (RTP), which facilitate near instantaneous EFTs. Their increased adoption and availability have been driven by considerable investments in applied technologies by banking institutions worldwide—on the back of customer demand but also by the popularity of non-bank payment providers such as PayPal who offer international general-purpose IFT payments. For instance, in the U.S. real-time payments are becoming more prevalent following the development of 'The Clearing House (TCH)'s real-time payments (RTP) system. The system supports EFTs that take less than 15 s and is open to regulated U.S. banks. However, at present the system has not been adopted by all banks given the costs and technologies needed to access the RTP network.

Credit/Debit Cards

Credit and debit card payments continue to be an area of both growth and innovation worldwide, and one of intense competition with technology giants such as Apple entering the marketplace. Apple was the first major technology company to enter the market in 2019 when they announced a new credit card, in collaboration with Goldman Sachs and Mastercard, called the 'Apple Card'. The credit card was mainly designed to be used digitally in a digital wallet on iPhones, although a physical Apple Card is also offered. The physical card has no account information or personal details on the card unlike conventional credit and debit cards and the Apple card requires users to have Apple products and Apple Pay. One of the strengths of the Apple Card is the lack of fees for international transactions and the absence of over-the-limit fees. A second strength, is that it is embedded within the Apple ecosystem, and offers a user-friendly experience and tools to help users manage debt and spending. Finally, innovative credit cards such as the Apple Card combine innovative security features such as the sophisticated facial recognition and fingerprint scanners with one-time pass codes to provide high levels of security. Similarly details of transactions including vendors, items purchased and even transaction value are withheld even from Apple.

There are also many new FinTechs aiming to erode incumbents market share by fighting to become consumers' main credit and debits card providers. Many of these are focusing on niche areas of the market. One example is a FinTech unicorn (i.e. a FinTech start-up with a valuation over $1 billion) called Brex. In recent years Brex has launched two corporate credit cards aimed specifically at technology firms, and which do not require credit checks and personal guarantees and with no annual fees. The first, 'Brex Card for Startups' claims to offer 10–20 times higher credit limits than competitors and a rewards program, while the 'Brex Card for Ecommerce', offers interest-free payments over extended periods with credit limits based on up to 75% of a firm's monthly estimated sales up to $5 million. Another example, is a French FinTech firm 'Deserve' which has been quite successful to date in attracting funding from large investors including Goldman Sachs. This firm specializes in providing credit card to non-traditional consumers including those with unestablished credit card histories including students who may have difficulty in obtaining credit cards from traditional providers. Deserve uses advanced artificial intelligence (AI) applied to non-traditional data to determine the credit worthiness of customers. The firm has also expanded its offerings by marketing its unique technological solutions to traditional financial institutions, which allows them to similarly offer alternative credit cards.

Finally, there are also emerging FinTechs aiming to make it easier for consumers to navigate the increasingly broad and complex debit and credit card market. One such firm is MobiMoney, which provides an innovative product that allows users to manage the use of credit and debit cards in new ways, including specifying spending limits, making restrictions on which geographical areas specific cards can be used, and allowing customers to instantly switch off a card to prevent its use if a card is compromised, which can limit losses to both card holders and financial institutions.

Contactless Payments

Contactless payments have witnessed huge growth worldwide. New technologies continue to be introduced that facilitate digital payments, and help meet governmental and supranational agencies objectives to increase access to financial and banking services, while simultaneously decreasing reliance of cash in economies. The importance of contactless payments is only likely to increase further in the future, with a 2020 study by Research and Markets (2020) into the impact of COVID-19 on online payment methods suggesting that half of the worldwide consumers are using digital payments more than before the COVID-19 pandemic. Such innovation is especially welcome in emerging economies, which, historically, have been characterized by low levels of financial inclusion.

Two key technological enablers of digital payments growth—especially in emerging countries, are the significant uptake in mobile phone ownership coupled with affordable access to the internet of things (IoT). Together they are helping in achieving goals of financial inclusion by facilitating access to banking and financial services for millions of people who previously may not have had the opportunity to access these services. One area of particularly significant growth, is in mobile payments (m-payments), which involves payment of goods and services based on the use of digital devices including smartphones and tablets.

Two of the most widely used forms of m-payment technologies are the Short Message Service (SMS) and Near Field Communication (NFC) in length, which are used to facilitate banking or payment services. In the case of SMS, payments are initiated by the sending of a text message to a provider of services. In different SMS is a remote form of communication between two mobile devices based on short texts, less than 160 characters words, a text containing details of the monetary value of the transaction and the customer's mobile number go to a SMS payment gateway number. Transactions costs are then charged to a buyer's mobile bill or to an online payment system. Goods or services are then provided and monies owed are transferred to the merchant. SMS payments can be conducted at point of sale (POS) or online on the IoT. Key advantages of SMS include its simplicity and convenience. It relies on text messaging, which many people are already familiar with, and does not require users to hold a bank account meaning it is especially attractive in countries where levels of financial inclusion and access to banking systems are low. SMS are also considered to be relatively safe and secure since both personal data and banking details are not disclosed during transactions. Both are notable strengths. However, while SMS does have notable strengths in terms of security and stability there are still known weaknesses. A key one relates to the potential for Man-in-the-Middle (MITM) in which communications between users and SMS payments gateways are intercepted between the point of origin and destination. This weakness has been strengthened over time as SMS payment providers have implemented more sophisticated forms of encryption and authentication for example. A difference weakness relates to chargebacks since users can request to have their SMS payment refunded. This could be initiated for legitimate reasons such as non-delivery of goods or services but also could be initiated fraudulently.

In terms of emerging economies, Kenya was the first country to adopt SMS payments. The company Safaricom launched M-PESA (mobile money) in 2007 based on SMS, and, in a country where much of the population lack access to banking services, M-PESA and M-Shwari have played key roles in helping address goals of financial inclusion. In fact, mobile money has become so popular that 72% of the country have adopted it compared to only 29% who have access to digital bank accounts (Financial Inclusion Insights, 2021a). Effectively, this figure means that in 96% of households at least one person uses M-PESA (The World Bank, 2018). Evidence supports a substantial positive impact on the socio-economic impact. For instance, Bharadwaj and Suri (2020) report large declines in the number of households living in poverty and increases in savings in areas where M-PESA agents (those that allow customers to deposit and withdrawn money) operate. By means of comparison, Tanzania M-PESA has also witnessed significant growth in SMS payment but not at the level of Kenya. There may be many reasons for this such as differences in geography and economic development. For example, Tanzania has historically lacked behind Kenya in economic development including the extent of banking system development and in financial literacy. Consequently, levels of financial exclusion have historically been much lower in Tanzania compared to Kenya. Currently 56% of adults can be considered as being 'financially included' with 55% of this figure coming from mobile money accounts (Financial Inclusion Insights, 2021b). M-PESA was introduced to Tanzania in April 2008 by Vodacom. At present there are two dominant providers of mobile money in Tanzania: M-Pesa and Pesa (proved by Tigo). Together they account for about 70% of the mobile money market according to data from Statista (2021).

There is also considerable adoption of SMS in developing economies. For example, in Sweden, where digital payments dominate, SMS payments have been adopted in areas including public transportation, vending machines, fundraising and TV voting among many others applications. One of the most popular forms is WyWallet, which was formed by T4 Sverige, which is a collaborative venture between all major mobile networks in the country (Three, Telenor, Tele2, Telia, Hallon, Halebop). In terms of the user process, for a first payment the user is required to enter their mobile number and in response they receive a one-time PIN number or password. For subsequent purchases single-click payments are possible, making SMS convenient in terms of ease of user experience and also because it is widely accepted. Moreover, costs of transactions can either be deducted from a monthly phone bill or processed separately.

While SMS payments have become especially popular in developing economies, in more developed economies, such as the UK, U.S. and those in European Union, NFC payments and mobile wallets have generally become more popular than SMS. NFC payments differ fundamentally from SMS in that they are based on short-range communication, which can be employed in both contactless payments and physical access control forms. Additionally, since NFC do not rely on mobile networks or Wi-Fi connection they are thought to be relatively secure, although there are still some security concerns. Like SMS, while NFC payments are highly convenient and user friendly, NFC is also vulnerable to MITM attacks despite the need for close proximity of two communications devices. For example, vulnerabilities surrounding device authentication can allow malicious users to implement MITM and other types of attack.

Another major growth market for mobile payments is China. In 2018 the value of mobile payments in China was almost $533 billion USD, and two firms, Ant Group and Tencent, accounted for 90% of this market alone, with over 890 million unique users. An analysis of the market by S&P Global in 2020 (S&P Global, 2020) suggests that new mobile payments providers including Du Xiaoman Pay and QQ Wallet are gaining popularity with more affluent and younger users especially, and it is also notable that under-30s account for almost a quarter of the entire market. NFC payments are significant in terms of transaction value, yet only represent less than 1% of the total market for mobile payments. A large reason for this is that payment providers such as Ant Group's Alipay advocate the use of QR codes and the IoT to facilitate payment transactions rather than NFC and SMS for example.

Apple's Apple Pay is one prominent example of a digital payment system that utilizes NFC technology, another is Google Wallet. Another major competitor to these providers, is Samsung Pay, which uses both NFC and an alternative technology with many similarities called Magnetic Secure Transmission (MST). In terms of the number of users worldwide, as of 2020 Apple Pay had 441 million users, compared to 100 million for Google Pay and Samsung Pay. However, all three lag significantly behind China's Alipay, with over 1.3 billion registered users, as well as WeChat with its 1.15 billion users. Despite this, Google, Apple and Samsung have achieved quite substantial market penetration based on the number of

	Apple Pay	Samsung Pay	Google Pay
Mobile device Compatibility	Apple devices including iPhone, iPad, Apple Watch, Mac models with Touch ID	Samsung devices including mobile phones, and watches	Android phones that support NFC and host card emulation (HCE) technology
Countries	60	27	40
Technologies supported	Near Field Communication (NFC)	Near Field Communication (NFC) and Magnetic Secure Transmission (MST)	Near Field Communication (NFC)
Authentication	Face ID; fingerprint; PIN code	Fingerprint; PIN code; Iris scan	Fingerprint, PIN code, or pattern
Cards	Apple Card; Major debit and credit cards and some loyalty and gift cards	Debit and credit cards; some loyalty and gift cards	Debit and credit cards; some loyalty and gift cards
Person-to-person payment supported	Yes	No	Yes

Fig. 3.2 Comparison of Apple Pay, Samsung Pay and Google Pay

countries that accept these forms of digital payments systems worldwide—albeit it with considerable differences in adoption by countries. The figure below presents an overview of the main features of Apple Pay, Samsung Pay and Google Pay to provide an illustrate guide of the state of the market currently (Fig. 3.2).

Peer-to-Peer (P2P) payments

Peer-to-peer payments is another important focus of recent innovation. P2P payments represent digital payments between two parties, which involve fund transfers between each party's bank account or payment card. Because such transactions are not geographically restricted and can be conducted on any computer or mobile device with access to the internet they are more convenient compared to traditional forms of payment. For instance, P2P payments can be between P2P mobile payment applications (apps) as well as online interfaces, and it is in the area of mobile P2P that much innovation activity and market growth has been focused in recent years. The gradual trend is towards an increase in the share of mobile

P2P payments, and this trend has been accelerated by the COVID-19 pandemic.

According to recent research by Valuates Reports (2020), the worldwide P2P market was valued at almost $68 billion in 2019 and is expected to reach almost 559 billion by 2027. The first, and most successful, P2P payment firm is PayPal. Their success has led to both new innovative start-ups entering the P2P payment market space over the last decade as well as major banks investing heavily in an effort to challenge PayPal's dominance of the P2P market. These include some of the largest banks worldwide. A notable feature of the P2P market since the GFC has been the entry of new firms who disrupt the market and then are acquired by existing players. For example, firms such as Venmo entered the market in 2009 and experienced fast growth. This growth attracted attention, and led to Venmo being acquired by Braintree and then subsequently by PayPal in 2013, when PayPal was owned itself by eBay Inc. A large reason for PayPal's acquisition of Braintree was to acquire a mobile application developed by the firm, which provided customers an easy to use mobile payment app that allowed them to make mobile P2P payments while leveraging social networks.

There is also evidence that banks are fighting back against FinTech-led P2P and against PayPal with banks working together to develop P2P networks such as clearXchange (cXc) in the U.S., which was launched in 2011 as a collaborative venture between a consortium U.S banks., and allows users to receive payments by email or phone from other registered users who have bank accounts with participating U.S. banks. cXc itself was acquired by another bank-led consortium in 2016, who has sought to ebbed new technologies to enable real-time P2P payments with enhanced security features.

Despite the significant growth of P2P payments worldwide there are still considerable issues with compatibility between platforms—this is a particular problem in Europe currently for example. It is therefore likely that new products will enter the P2P payment market that offer more universal solutions that allow P2P payments to be made in real-time as well as cross-border. One example of such a product is Joompay, which entered the European market in February 2021 initially in Luxembourg. Joompay's mobile app allows users to send and receive money with anyone cross-border and at no cost.

3.2.1.2 Banking Channels

The second major area of innovation in FinTech identifying from our patents data is '*banking channels*'. This includes *Cash Dispensing Machines*, *Internet and Mobile Banking*, *Digital Wallets* and *POS terminals*.

Cash Dispensing Machines

As cash has become less common in leading economies including the UK cash dispensing machines or 'automatic teller machines (ATMs) have been in steady decline. Yet in other countries—and emerging in markets—the demand for automated teller machines (ATM) remains high.

Technological innovations around cash dispensing machines have sought to improve user experience, with added features, and interfaces designed to echo sleek mobile banking and payment apps being packaged into new ATMs. An important element of innovation in this area has been around the security of ATMs machines, which have historically been vulnerable to security threats both locally, at the physical location of the ATM, but also remotely through the internet. More specifically, new ATM machines are offering a wealth of new features including card-less machines that instead allow customers to make withdrawals and access wider banking services using contactless means. Other features include video banking with the facility to talk to bank teller through the ATM and to get help, support and access to wider banking services even outside of a bank branch's opening hours for example, and the ability to instigate transactions before visiting an ATM. Furthermore, there is also a wider range of services offered by ATMs including cash and cheque deposits, bill payment and the ability to pay for goods and services and the ability to cash out cryptocurrencies. For example, in the UK cash machine operator CashZone signed an agreement with cryptocurrency firm BitcoinPoint in late 2020 to allow customers to withdrawn between £10 and £500 at 16,000 ATMs in the UK. In addition to the above, there are also new 'drive-up' ATMs that allow customers to make withdrawals without leaving a vehicle. These services have in part contributed to the growing interest in digital money at large and the rises in trading activity, speculative and otherwise, across cryptocurrency exchanges (King & Koutmos, 2021; Koutmos, 2020; Koutmos et al., 2021).

Internet and Mobile Banking

This category includes innovations in the area of access to banking services through the internet, including online and mobile banking and mobile banking apps. This is an area that has experienced considerable development and market growth in recent years. Furthermore, the popularity of internet and mobile banking has risen further during the COVID-19 pandemic—especially so in the case of mobile banking. Even before the crisis mobile banking was popular with consumers in many countries. For instance, a 2020 survey by Insider Intelligence revealed that 68% of survey participants used mobile banking in the UK and further revealed that 62% would switch banks if the mobile banking user experience failed to meet their expectations. In addition, among the 68% of consumers who used mobile banking, 86% cited mobile banking as their primary banking channel. Aside from usability another major concern of consumers is security. In fact, this was highlighted as the most important factor surrounding mobile banking app use by UK customers in the UK Mobile Banking Competitive Edge Report 2020.

Recognizing such trends, and faced with an increasingly competitive marketplace, banks have been investing heavily in this area. One example, is NatWest Group who has invested heavily in internet and mobile banking over the last few years in order to improve the quality of their offerings. NatWest Group, like other banking institutions, has embedded new features into their mobile banking apps to improve areas such as security control and account management, including the ease through which customers can receive help and support and demand. For example, the Bank of America has worked on improvements to their chatbot, Erica, which allows customers to interact with the chatbot by voice, tap or text. The chatbot helps customers with a wide range of banking services including balance inquires, monetary transfers as well as wider services that help customers manage their accounts using data-driven incites to offer customized suggestions.

Digital Wallets

Digital wallets, or 'eWallets', function like a prepaid credit account. Digital wallets can store a customer's payment cards, among other types of cards and information. With card information stored in a digital wallet a customer no longer has to enter personal bank account details to complete transactions. Instead they can simply authorize a transaction using embedded mobile security features such as fingerprint scanners or

Table 3.3 Top 10 countries for mobile and digital wallet adoption

Rank	*Country*	*% of country population using mobile and digital wallets*
1	China	47
2	Norway	42
3	United Kingdom	24
4	Japan	20
5	Australia	19
6	Colombia	17
7	United States	17
8	Singapore	16
9	Canada	16
10	Austria	16

Source Created and tabulated by authors

FaceID. These help to streamline and simplify the payment process from the point of view of the customer and also improves transaction security.

Digital wallets are a very fast growth area and especially so with younger generations including 'Millennials' and 'Generations Z's'. The following figure shows the top 10 countries by mobile and digital wallet adoption based on 2019 data collected by Payments Cards and Mobile (Table 3.3).

In the UK digital wallets are predicted to become the dominant payment channel according to a worldwide survey of 8000 people by Paysafe. While in China digital wallets were used in 54% of e-commerce in 2019 (Morgan, 2019). The increased adoption of digital wallets is contributing to the decoupling of payment instruments, such as debit and credit cards, with bank accounts. Moreover, increasingly the use of physical credit and debit cards are being replaced by digitalized forms stored in digital wallets, such as those provided by companies such as Apple, Samsung and Google as we discussed earlier in Sect. 1.4. However, PayPal remains by far the dominant player worldwide. Other providers such AliPay are dominant in the Asia Pacific regions.

There are also differences in market share between incumbents and FinTechs. In developed economies, such as the UK, banks have invested heavily and currently seem to be outperforming new comers with digital wallets, yet in other countries—especially emerging economies, FinTechs are eroding the market share of banks to a greater degree. In China and India, which account for 70% of total digital wallet users worldwide, digital wallets have been readily adopted by urban populations in particular (Boston Consulting Group, 2020). For instance, it is estimated that 84% of the proportion of urban consumers in Southeast Asian region will use digital wallets compared to 49% in 2019 (Boston Consulting Group, 2020). Yet, in India, in the last few years, banks have been handed an advantage in the competition with FinTechs to be customers' main digital wallets, with the introduction of the Unified Payments Interface (UPI), which was developed to facilitate real-time payments between banks accounts of participating banks. The impact of UPI coupled with stricter 'know-your-customer' requirements has already forced some FinTech out of the market while others have been able to evolve to compete.

Point-Of-Sale (POS) Terminals

There has also been recent innovation related to point-of-sale (POS) terminals, which is helping to streamline the payment process, increase flexibility and improve security for both consumers and businesses. One innovation, originally developed by Amazon, is the 'no checkout POS', which is based on technology Amazon refers to as 'Just Walk Out' technology, which uses a combination of cameras, computer vision techniques, sensor fusion technologies and deep learning. With this system, customers need the Apple Go app to be installed on their mobile device, and to be connected to their Amazon account for billing. As a customer walks around a store items are placed in their 'virtual cart', with payment then taken when they leave the store. The first Amazon store of this type opened in 2016 and, as of early 2021, Apple has opened 25 stores in the U.S. with this technology and one in London, UK. In 2020 Amazon also began selling its 'Just Walk Out' technology to other retailers so it is likely that retail sales without cashiers or checkouts will become more common over the next decade. In addition to Amazon, other companies have started to experiment with similar technologies, including Alibaba in China who has introduced the concept to its 'Tao Café', and Saturn /Media Markt in Austria.

Considerable developments have been made in terms of the integration of personal smart devices including mobile phones and tablets with POS systems, as well as wider adoption of e-commerce point of sale systems that can handle both offline and online transactions. This has advantages for customers, such as allowing for more payment options, as well as merchants who have more sales opportunities and access to valuable data that can facilitate real-time control over inventory, cross-channel promotions, as well as removing the need for manual data entry, for instance. These include mobile POS, which function on a mobile device and which do not require local storage of data, with data being stored in the cloud instead. There are now a huge variety of such offerings, which vary in terms of the types of business they are aimed at, as well as processing and monthly fees. Some examples, include Square, Vend, Clover and Lightspeed.

Lastly, increasingly there are exciting integrations of biometric science to POS. These include new technologies which include vein-scanning checkout systems such as Fujitsu PulseWallet and Quixter vein scanner. Both of these first-of-their-kind vein-scanning checkout technologies were first introduced as concepts in 2014. The technology involves a scan of a person's palm, which has unique vein patterns and blood flow characteristics, this information is then encrypted and linked to the customer's digital wallet including credit and debit cards. Once registered, customers can then make payments by simply scanning their payment at POS. Presently, new patents are being filed that aim to mitigate difficulties with facial recognition software in the current generation of mobile phones. This area of innovation has been accelerated following the emergence of this problem during the COVID-19 pandemic, in which an inability to make contactless payments at POS with mobile smart devices using current facial recognition software was discovered. In the near future facial recognition software will improve to address this issue. For example, GBT Technologies Inc, a company based in California, filed a patent in early 2021 for a computer and mobile-based AI recognition system that claims to go beyond the existing parameters of facial recognition software and can identify users irrespective of whether a mask or particular clothing is worn. In addition to the integrations of facial recognition software in smart devices to enable payments through digital wallets facial recognition is already being used by POS systems. One example is the Finland-based company Uniqul, who combines facial recognition software with NFC to provide an extremely fast secure payments system that can be offered at a POS terminal or on a tablet-based POS.

3.2.1.3 Financial Entities

This area of innovation activity includes *Clearing Houses*, which facilitate the clearance of payments and other financial transactions, as well as *Payment Gateways*, that authorizes credit card as well as other direct payments.

Clearing Houses

Originally developed to act as trusted third parties that facilitate transactions between banks—namely by offering clearing services for paper checks between banking institutions, in return for transaction fees, clearing houses today process primarily paperless electronic transactions. As we noted earlier in this chapter, there has been much development in real-time payments (RTP). In the U.S. The Clearing House, a private institution, launched its RTP network in 2017 to provide financial institutions in the country. It has been widely adopted and today over 70% of U.S. deposit accounts now have access to the network. However, this early dominance may soon be challenged by the U.S. Federal Reserve's FedNow system, due to be launched in 2023 or 2024. It will be interesting to see whether both private and public RTP networks can successfully co-exist. Part of the reason for The Clearing House's success is that a venture owned by the 25 largest U.S. banking institutions. At current much of the FinTech innovation around RTP has been by third-party banking technology providers who have offered banks streamlined interfaces, which allow them to communicate with the RTP network. These include firms such as Sherpa technologies, Jack Henry and Associates and FIS. For example, FIS is helping to increase the number of banks in the U.S. who can offer real-time payments through the RTP system, by providing a separate system that allows small- and mid-size banks to connect to the RTP system without incurring the levels of costs and investment as well as navigating the complexity needed to connect directly. Similarly, another FinTech company, Alacriti, is offering a cloud-based platform called Orbipay, which allow credit unions and banks of all sizes to access the RTP network without the need to invest heavily in technology to access the RTP network directly.

In the future, the importance of traditional clearing houses may be diminished by new decentralized solutions built on blockchain technologies that could offer lowest cost and more efficient alternative payment channels that remove the need for trust to be placed in a third party.

Payment Gateways

Payment gateways facilitate payments by validating credit and debit card transactions either online or offline. Payment gateways are helping to drive the worldwide growth in online e-commerce, and there are numerous new offerings being developed in the global marketplace. One example is UK based, Paymentsense, which specializes in the provision of face-to-face and online digital payment solutions to UK and Ireland based small businesses, which it offers through its online payment gateway. Innovation in the area of payment gateways coincides with an increased desire by many businesses to use more than one payment gateway in order to improve the reliability, flexibility and efficiency of payments as customers themselves are utilizing a wider range of payment methods, which makes choice of payment gateway important.

Much of the innovation activity and investment by firms has been in improving security around online transactions, with firms including Infibeam Avenues significantly upgraded their payments gateway. In the case of Infibeam its payments gateway, CCAvenuem, has been made more attractive to potential clients with the acquisition of PCI DSS version 3.2.1 certification.

Innovation is important in the payment gateways market, since the market is growing rapidly with new innovations and offerings being developed at a frantic pace. The size of the market and growth potential is encouraging new firms into the market—not just emerging FinTech firms or traditional financial sector providers, but also firms from other industries. For successful firms the rewards are attractive, with Insider Intelligence predictions suggesting online payment providers will receive $138 billion in fees by 2014, compared to $82 billion in 2018. There are many diverse players in the market already, with technology giants such as Amazon, as well as FinTechs such as FIS, who acquired the successful Worldpay in 2019, and Stripe, a FinTech unicorn with a valuation of $36 billion (in 2021). A lot of the payment gateways market is region based with firms such as Alipay dominating the Chinese market for example. Finally, like areas of payments there is already significant consolidation in the market and this will likely continue over the next decade.

3.2.1.4 Reporting Analytics

Much innovation is ongoing in ***Reporting Analytics*** within the categories of *Data Analytics & Business Intelligence*, *Wealth Management*, *Debt Management*, *Risk management*, *Risk management*, *Big data, and Credit Scoring*.

Data Analytics and Business Intelligence

Business intelligence (BI) and data analytics (DA) are highly important areas of innovation, which are helping to shape the evolution of the FinTech sector by providing a source of important differential between firms. According to data from Fortune Business Insights (2020), the worldwide BI and DA market was valued at $20.6 billion in 2019, and is forecasted to reach $39.35 billion by 2027.

In a crowded banking and finance sector DA and BI can offer firms competitive advantages in areas encompassing fraud detection, understanding key trends and customer preferences, risk modelling, process improvements and personalized marketing. One example where BI and DA are making a difference, is in the robo-advising industry, an industry which provides financial advice and investment management online with little or no human interaction based on machine learning (ML) and artificial intelligence (AI) built on rich datasets. In the robo-advising sector, both emerging FinTechs such as Betterment, Wealthfront and Personal Capital, who essentially started the robo-advising industry, have been joined by major established financial institutions including Vanguard, Charles Schwab, Merrill Lynch and Fidelity, and competition is intense. Over the last few years, the use of business intelligence and BI has helped give established financial industry players such as Charles Schwab a competitive edge over many emerging FinTech firms. The performance of Charles Schwab and other established players has so far largely been built on the use of data analytics and business Intelligence rather than on being market leaders in terms of the sophistication of robo-advising products—which is largely being driven by FinTechs. Other traditional players in the financial sector, such as BlackRock have been aiming to grow their market share by acquiring FinTech's such as FutureAdvisor.

Other examples include, U.S. company, Amenity Analytics, who use machine learning and natural language processing to help financial sector firms assess customer sentiment. Additionally, there are FinTechs specialize in providing financial sector firms with customized solutions, driven by predictive analytics, that can help them digitalize, automate and streamline existing processes in areas including regulatory compliance and trading.

Wealth Management

Wealth management is the provision of advice and execution of investments in return for a fee, and includes financial services such as investment management estate planning and retirement planning. The wealth management industry is currently going through a period of very recent disruption from FinTechs, which are beginning to reshape the industry and bring traditional wealth management products to a much wider pool of customers who might otherwise not be able to access such products under the banner of 'Wealthtech'. Moreover, FinTechs are helping to expand the range of products offered as well as lowering costs and decreasing the complexity of financial services. These trends are summarized by Philippon (2020) who summarizes that 'the nature of fixed versus variable costs in robo-advising is likely to democratize access to financial services'. Yet, the application of FinTech based innovation to the wealth management industry is still in its infancy, with many traditional providers still wary of technologically driven innovation, and largely failing to digitalize and offer technology-led solutions to consumers.

One area of growth is in digital and robo-advising. For example, FinTechs, such as Betterment, previously mentioned in Sect. 4.1, are now providing innovative technological solutions that help consumers make important choices regarding their investments through customized education, guidance and advice, and then automatic the management of customer wealth, in areas such as retirement portfolios. Noting the technological advantages of, and competition posed by, FinTechs, a number of incumbents are choosing to partner with FinTechs. For instance, FinTechs SigFig and Jemstep have partnered with Wells Fargo and Morgan Stanley, respectively, while another FinTech, FutureAdvisor, has formed partnerships with traditional players including BBVA Compass, RBC Wealth Management and US Bank Wealth Management.

Finally, and in addition to strategic partnerships with FinTechs, the wealth management industry has also been going through a period of recent consolidation since 2017, which is likely to continue in the near future—spurred on by FinTech disruption as well as the COVID-19 pandemic. An example is Charles Schwab's $28 billion all-stock acquisition of Ameritrade in October 2020, which the firm hopes will improve its economies of scale and scope.

Debt Management

The traditional debt management industry, which involves a formal agreement between debtors and creditors known as a debt management plan to address the terms of an existing debt, is being transformed by the emergence of FinTech debt management and new FinTech debt management companies, such as Cambridge Credit Counselling, GreenPath Debt Solution, InCharge Debt Solutions, TrueAccord, CollectAI, CollectionHub, indebted, Attunely and Qualco. In contrast, to traditional debt management for advice and support usually relies on meeting credit counselors face-to-face, FinTech debt management makes use of innovative technologies to offer 'smart' digital platforms that provide customized recommendations and tools to help debtors manage their debts, which may be split across multiple creditors. For instance, they can allow for a single payment to be made, which is then distributed among all creditors. Furthermore, face-to-face interactions with credit counsellors are being replaced with online and mobile debt counselling services. Such products are being offered on digital platforms that make use of AI and multichannel communication to deliver solutions that help both creditors and debtors.

The emergence of the FinTech debt management industry is an important development given a pressing need to help people better manage their debts—especially in economies where credit plays an important role. To illustrate this point, in the UK approximately 1 in 4 adults can be classified as being 'financially squeezed', which means that they have significant financial commitments but lack sufficient savings making them vulnerable to an unexpected bill that could put them in arrears (The Money Advice Service, 2016).

Risk Management

The role of actuaries and risk managers is evolving in line with FinTech based technological disruption in key sectors such as the insurance industry, the traditional home of actuarial science. Like other areas of finance, actuarial science is changing with new techniques and innovative software built on big data and advanced analytics that are facilitating real-time analysis of individual claims and policy data. In addition, automation in areas such as loss reserve analysis is helping insurers have the potential to increase efficiency, accuracy and lower costs by reducing the need for human input. Similarly, Robotic Process Automation (RPA), which involves the use of AI and machine learning to perform repetitive and high-volume processes traditionally carried out by humans, is helping to automate common data processing and handling tasks. This is allowing actuaries to increasingly devote greater attention to more value enhancing activities.

Rapidly developing FinTech risk management functions are also helping financial firms to better manage risk exposures and to adhere with the need for regulatory compliance. One key area to emerge is RegTech, which is the application of advanced technologies such as machine learning and AI to the financial sector, to improve regulatory monitoring, reporting and compliance. More specifically, RegTech firms and products are helping firms to manage their risks, monitor transactions, comply with regulatory requirements including reporting and identity management and control. As highlighted in the figure below compliance is the biggest focus of RegTechs, with over twice as many firms as Identify Management and Control, which represents the second largest RegTech cluster.

Increasing regulatory complex is placing substantial demands and costs on institutions. For example, in Europe alone over 50,000 regulations were implemented across the G20 countries alone. This is placing very significant demands on financial institutions, which has led to the rapid emergence of the RegTech industry.

RegTech compliance firms such as Raptor Compliance GmbH, Ai XPRT, Compliance Solutions Strategies, CUBE and Acarda GmbH are helping various firms to navigate and comply with evolving regulation. For example, Switzerland based Raptor Compliance GmbH provide technological solutions, which automate firms' compliance with key regulations including General Data Protection Regulation (GDPR) requirements, while firms including Acarda GmbH are specializing in providing regulatory reporting solutions to financial institutions including banks and insurance companies. Moreover, other RegTechs firms are specializing in identity management and control, to help financial institutions in meeting know-your-customer requirements (Arner Barberis, Buckley, 2016), as well as other areas, including the recording of financial and regulation conversations. In this area, firms such as Recordsure are using machine learning and AI to identify potential risks in conversations, which can then be used to help train staff in best practice surrounding dealing with sensitive data.

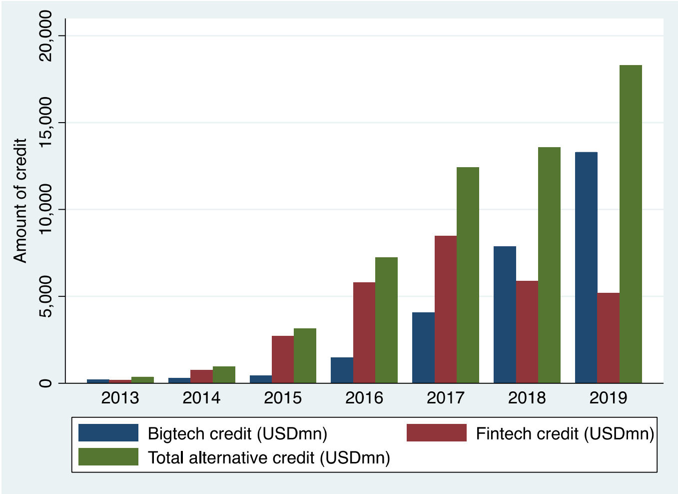

Fig. 3.3 Alternative credit growth worldwide (*Source* Created and tabulated by authors)

Big Data

Big data is playing a key role in the FinTech revolution by acting as a central enabler of financial services innovation. As we have already discussed, big data is being used extensively in the financial sector, with a wide range of advanced techniques such as ML and AI being applied to large and novel dataset. These techniques and big data are helping financial institutions to make more effective use of payments data and mobile device data to better understand credit risk often in partnership with 'big tech' firms. Similarly, big data has facilitated the entry of new financial intermediaries who provide 'FinTech credit' using digital lending models such as marketplace lending and peer-to-peer lending. In particular, big data has been catalyst behind the expansion of alternative credit worldwide. As illustrated in the following figure, which the growth of BigTech, FinTech, and total alternative credit worldwide based on a sample of 79 countries for the period of 2013 to 2019, there has been very significant growth in alternative credit and most notably in BigTech (Fig. 3.3).

Big data is being used by both traditional financial institutions, and even more so by FinTechs, who are harnessing the power of real-time big data to predict customer behaviour and provide sophisticated assessments of risk. It is also contributing to develop new products and solutions that are tailored to specific customers. For example, big data is helping financial sector firms track the financial habits of customers in real-time, which allows for predictive technologies to be employed to predict customer requirements and offer products and services to meet evolving needs. Furthermore, customer segmentation has become more important and achievable with big data helping firms to also better understand the financial choices and requirements of different customers based on socio-economic groups as well as factors including age and gender. Segmenting market in this way, allows FinTechs to improve customer experiences by identifying and addressing, more closely, specific market segments through the provision of customized solutions and products.

Another way big data is helping drive innovation, is in the development of reliable fraud detection systems as well as providing better risk assessments. For instance, machine learning techniques and natural language processing techniques allow for the development of new algorithms that can detect previously undetectable patterns in big data that can be useful in identifying potential fraud. One example is DataRobot, a U.S. based FinTech, who provide an automated machine learning platform that analyses both traditional data and non-traditional datasets, such as social media data, to help banks and other lenders assess the credit risk of borrowers, and also to detect fraud based on natural language processing techniques. Another example is MasterCard who are using AI and machine learning to analyse detailed transaction data to provide real-time evaluation of transactions to identify potential fraudulent transactions. A third example, is Feedzai, another U.S. FinTech, who is using real-time machine learning to analyse big data and predict fraud—with a claimed 95% accuracy.

Finally, big data is also transforming customer experiences by helping in the development of next-generation virtual assistants such as the Bank of America's 'Erica' chatbot, launched in 2017, which employ predictive analytics and natural language processing built on big data, to provide more sophisticated and personalized interactions with bank customers, and is capable of performing a wide range of banking services for customers.

Calculation, Processing and Utilizing Credit Score of Customers

Another important area of innovation is credit scoring. As we found in the previous section big data is helping to drive innovation across the financial sector. There is now a wealth of both traditional and non-traditional data on almost every individual worldwide who has used the financial system and/or internet which can be harvested in order to improve the prediction of consumer payment behaviour as well as defaults. For example, even relatively simple data such as whether an individual owns an IOS device can be a valuable predictor of someone being in the top quartile of income distribution (Bertrand & Kamenica, 2018).

Traditional credit scoring systems tend to perform relatively well for individuals with financial well-off consumers, and those with established credit histories but not particularly well for those with a limited or no credit history. This results in more difficult and costly access to finance for borrowers in this group. A typical example being university students given their typically relatively young age and lack of established financial history. An example of a FinTech that is using non-traditional data and technology to address this is CreditLadder in the UK, which aims to ensure that individuals' on-time rent payments are included in Experian and Equifax credit reports, which along with TransUnion make up the three largest credit reporting agencies or 'credit bureaus'.

Big data, non-traditional data and computer science are helping to transform the nature of credit scoring. For instance, the potential of ML techniques and big data for credit scoring is shown in a recent empirical study by Gambacorta et al. (2019) who compare the performance of credit scoring models built on these techniques with traditional loss and default models using loan-transaction level data between May and September 2017 for a leading (but undisclosed) Chinese FinTech. The authors find that the model built on ML and big data outperforms the traditional data and especially so during periods of adverse shock to aggregate credit supply. Moreover, the outperformance of the ML model is strongest for borrowers with shorter credit histories.

Finally, consumers are also benefiting from the emergence of new FinTechs that offer all-in-one-credit management solutions that allow customers to view their credit scores, receive advice on how they can improve or maintain them and to query credit report errors. Popular platforms include U.S. based FinTechs Credit Sesame, Credit Karma and MoneyLion, and Zhima Credit in China, which is a product of the Ant

Group (part of the Alibaba Group), and which utilizes a huge dataset of over 1.2 billion users of the Alipay payment app and analyses non-traditional dataset including online activities and spending to establish credit scores. The emergence of innovative credit scoring platforms such as Zhima Credit is especially valuable in China given that three-quarters of the population lack a credit history.

3.3 Conclusion

In Part I of this chapter we began by establishing the importance of the concept of innovation in driving economic change based on classic theoretical contributions in the academic literature, before outlining the specific importance and impact of innovation in the financial sector—highlighting how FinTech is disrupting numerous areas of banking and finance and contributing to economic welfare. We then preceded, in Part II to analyse key areas of FinTech innovation and development worldwide by using data on patents, as a key measure of innovation activity, filed with the United States Patent and Trademark Office (USPTO) to identify four key areas of FinTech innovation in: Payment Channels, Banking Channels, Financial Services, and Reporting and Analytics. The remainder of the chapter then discussed each of these broad areas of innovation including more granular FinTech areas within each of these categories. Subsequent chapters are built on the knowledge distilled in this chapter to provide more detailed and focused discussion on specific areas of FinTech and how banking and financial sectors are being disrupted worldwide.

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CHAPTER 4

Cryptocurrency Mining Protocols: A Regulatory and Technological Overview

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4.1 Introduction

Money is an important commodity in developed and developing economies alike. It functions as a vital means of exchange and store of value, facilitates spending and saving, and can help drive innovation and country-level economic growth by improving the efficiency of allocation of productive economic resources. While money has a rich history going

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back approximately 5000 years, in the twenty-first century, we have been experiencing a fundamental change in how money is used in society, with a movement toward a more digitalization realization of money. This includes increased use of credit cards, internet and mobile banking, the use near-field-communication mobile payments, alongside the emergence of so-called ‘cryptocurrencies,’ which is the main focus of this chapter.

Despite being a relatively new phenomenon, cryptocurrencies, or digital currencies, continue to gather widespread interest from the general public, practitioners, regulators, and policy makers alike. Headlines continue to be made around the world, such as a recent public disclosure by Tesla, on the 8 February 2021, that they have invested 1.5 billion USD in Bitcoin and may accept it as a means of payment in the future (Wall Street Journal, 2021). More generally, interest in cryptocurrencies also coincides with investors searching for alternative asset classes, which could be useful to hedge portfolio risks for example, as well a general buzz surrounding the potential for cryptocurrencies and, especially, blockchain technologies, to solve real economic and social problems (Koutmos et al., 2021). For example, cryptocurrencies and blockchain can facilitate international transactions and cross-border commerce. Indeed, the potential uses of blockchain technologies continue to expand at a rapid pace. These include the use of smart contracts (such as those on the Ethereum blockchain) to solve issues with trust and security, in areas including the establishment of land and property ownership rights, maintenance of patents’ healthcare records and electronic voting systems to name just several examples. Yet the inherent anonymity of cryptocurrencies and their borderless nature makes them a potentially attractive conduit for illegal and illicit activities (Foley et al., 2019). Moreover, market behaviours including potential manipulation in cryptocurrency markets continue to be a source of major concern of regulators (Griffin & Shams, 2020; King & Koutmos, 2021).

The history of cryptocurrencies and distributed ledger technology,[1] on which cryptocurrencies are based, can be traced back to at least 2009, and specifically to the introduction of Bitcoin on January 3, 2009 on the back of a 2008 white paper titled *Bitcoin: A Peer-to-Peer Electronic Cash System* published by Satoshi Nakamoto—widely assumed to be a pseudonym for a group of cryptographers rather than one individual. Despite Bitcoin and

[1] Ledgers and distributed ledgers are discussed later in this chapter.

its associated blockchain representing the genesis for the establishment of all cryptocurrencies, previously published white papers set out ideas for digital money and decentralized blockchain like technologies. Two exemplars of this were '*B-money*', in which computer engineer Wei Bai discussed, in 1998, a means through which digitalized money could be transferred using untraceable digital pseudonyms, and '*Bit Gold*' an idea for a financial system that involved combining various aspects of mining and cryptography to establish a decentralized distributed append-only ledger-based technology.

As of February 2021, there are currently over 2000 cryptocurrencies in circulation, and many such as Bitcoin are currently trading at record highs. While there has been a proliferation of new virtual currencies that have come into existence over the last few years, Bitcoin (BTC) has steadfast maintained its position as the highest value cryptocurrency with a current price on the 8 February 2021 of over 43,445 USD and market capitalization of over 809bn USD (Koutmos, 2020). In terms of the other top five cryptocurrencies, based on data from CoinMarketCap from the 8 February 2021, the second most popular cryptocurrency is Ethereum (ETH) with a price of 1745 USD and market capitalization of 198bn USD, third is Tether (USDT) with a price of 1 USD and market capitalization of 28bn USD, fourth is Cardano (ADA) with a price of 0.7 USD and market capitalization of 21bn USD, and fifth is Polkadot (DOT) with a price of 22 USD and market capitalization of 20bn USD.

The rest of this chapter proceeds as follows. We begin in Sect. 4.2 by covering the 'digitalization of money' and the shift towards cashless economies, we then proceed, in Sect. 4.3 to discuss central bank issued digital currencies. In Sect. 4.4 we explore the regulatory treatment of cryptocurrencies worldwide, while in Sect. 4.5 we provide a historical background to ledgers before proceeding, in Sect. 4.6, to discuss differences between centralized and decentralized ledgers. Section 4.7 questions whether cryptocurrencies could become widely accepted as means of payment and as fiat. Section 4.8 reviews consensus algorithms employed by cryptocurrencies to coordinate between network nodes and to establish network consensus in order to validate and process transactions. Finally, Sect. 4.9 closes with some final thoughts.

4.2 The Digitalization of Money

The digitalization of money has been gathering pace since the global financial crisis of 2007–2009 (GFC) and has accelerated further during the Covid-19 pandemic. Despite this traditional paper and coin-based forms of currency still remain dominant forms of payment in many countries—and especially so in the case of small transactions. However, this is rapidly changing and increasingly goods and services are being paid for without cash. These include public transport and air travel but also weekly family food shops for instance. At the forefront of this revolution has been the growth in ownership of mobile devices and their use as a means of cashless payment. In emerging economies especially, the adoption of smart phones and the internet of things (IoT) has helped countries to meet their goals of financial inclusion by facilitating access to banking and payments systems. This growth has also coincided with a steep decline in the number of automatic teller machines (ATMs) used to access bank notes conveniently, as well as the number of bank branches in developed economies such as the United Kingdom (UK). Furthermore, the rapid emergence of cryptocurrencies and blockchain technologies, as well as specialized FinTech startups in other areas relating to payments and financial services, have increased pressure on traditional banking institutions for deposits, lending, and payments. Finally, as we discuss in Sect. 4.3, central banks and governments around the world are beginning to explore the introduction of central bank digital currencies based on blockchain technologies.

In its simplest guise digital money is the digital equivalent of banknotes and coins. While digital money may represent only a digital equivalent of physical cash, it can be seen as holding several notable advantages over physical cash and coin. These include helping to combat the use of money to fund criminal activities such as money laundering, terrorism, and tax avoidance, as well as its role in boosting competition for financial services. In countries such as Sweden where cash is scarce and digital money is the norm, the number of armed robberies has decreased substantially as has tax avoidance, which is a real issue in many economies. Another feature of digitalized money, rendered even more salient by the Covid-19 pandemic, is that traditional money is known to harbour viruses, protozoa, and bacteria. It may therefore help spread dangerous viruses and infections (see for example: Maritz et al., 2017). Additionally, cash and coins can be contaminated with traces of harmful drugs such as cocaine. For example, in a study by Oyler et al. (1996) that analyzed US one-dollar bills for cocaine contamination, 79% of notes samples were found to have traces of cocaine, thereby suggesting that drug contamination may be common on bank notes. For these reasons, the Covid-19 pandemic has further accelerated the trend towards cashless payments in major economies. In fact, there are numerous examples of retailers such as supermarkets refusing cash payments and only accepting digital payments. In the UK, where both physical cash and coin and cashless payments are widely used and accepted as legal tender, there are numerous accounts in the press of customers being turned away by shops who have refused to accept cash despite the fact it represents legal tender and as such should be legally accepted. In fact, a 2020 survey conducted by the consumer group 'Which' found that one in ten people had their payment refused by shops when they tried to pay using cash during the Covid-19 pandemic; during a time when UK lockdown restrictions meant that only essential shops were allowed to open (Which?, 2020). Conversely, also in the UK several major supermarkets—notably Co-op and Morrisons—have been impacted with technological issues during 2021 that have actually prevented credit and debit card payments being taken in store and necessitating payments with bank notes and coins. Given the potential for technical issues to occur, as well as the fact that citizens, even in developed economies like the UK, may not be comfortable or have the scope to fully adopt digital payment forms, whether economies should become completely cashless remains a source of considerable debate.

Despite these issues, many countries are actively engaged in efforts to move towards cashless economies. For example, in 2016 the Indian central bank, the Reserve Bank of India (RBI), launched 'Vision-2018' to promote lower reliance on cash in the economy and to encourage a shift towards digital payments. As part of a number of reforms to encourage this switch, the country undertook a radical demonetization on the 8 November 2016, which involved the withdrawal of 86% of existing currency from circulation. The objective was to reduce the role played by, what was referred to by prime minister Narendra Modi, the 'shadow economy'. Another tangible example of a country-level effort to become cashless is Vietnam. Although less developed compared to many low cash economies, in Vietnam widespread adoption of technologies such as the internet and mobile phones have helped accelerate quick progress towards government objectives to become a cashless, or near cashless economy. Although cashless payments are increasingly been adopted, Vietnam differs from the majority of examples cited earlier in this chapter, in that e-commerce is still in its infancy with 60% of citizens still yet to make an internet-based purchase. A further example of a concerted policy push towards digital currency is the United Arab Emirates, where a national payments strategy has been implemented with a goal to reach a figure of 70% cashless payments by 2030. Lastly, in terms of the extent to which countries have embraced digital money, countries closest to true cashless economies include China, Sweden, Finland, the UK, Australia, and South Korea. Sweden in particular has the objective of being the first completely cashless economy in the world by 2023 and is already quite close to realizing this ambition. For instance, data from Riksbank, the Swedish Central bank, shows that in 2020 only 6% of total payments in Sweden were made using cash.

4.3 Central Bank Issued Digital Currencies

Since the introduction of Bitcoin and blockchain technologies, central banks have been actively considering, and, in some cases, experimenting with the issuance of central bank issued digital currencies. A central bank digital currency represents an electronic fiat claim on a central bank which can be used as medium of exchange, store of value, and unit of account (Kumhof & Noone, 2018). Although these are not cryptocurrencies per se, proposed projects do seek to utilize distributed ledger and blockchain technologies. However, they differ from conventional cryptocurrencies in that trust still has to be placed in a centralized authority. Like traditional fiat, central banks would remain the sole issuer of legal tender, and each unit of digital currency would continue to represent a medium of exchange, store of value, and unit of account. Conceptually, CBDC would perform the same function as traditional fiat currency, yet each unit would be digital and issued exclusively by a central bank. However, it is important to note that a central bank's role would be likely much more significant under a central bank digital currency system, and the corresponding importance of commercial banks and correspondent banking likely less. This has implications for the nature of financial intermediation in economies.

Although, the concept of central bank issued currencies is not a new one and they have been attempted previously, such as in Finland in 1992 with the Avant system, since the introduction of blockchain the idea has grown to become one high on the agenda of governments and central banks. This attention has grown even more significant following the announcement of Facebook's Libra (subsequently renamed Diem) project,[2] which intensified concerns by central banks that private virtual currencies could unsettle central bank issued currencies. For example, a 2020 survey of 66 central banks by the Bank for International Settlements (BIS) revealed that 80% of central banks were either actively researching or experimenting with the implementation of central bank digital currencies.[3]

In terms of recent examples, the European Central Bank (ECB) has been exploring the possibility of a digital euro to supplement physical cash. As of 2021 this project looks increasingly likely to be approved, with current ECB president, Christine Lagarde, stating at the Reuters Next conference, held in January 2021, that she believes a digital euro will be introduced. If a digital euro is adopted, the project will be complex and challenging, given the importance of the euro currencies and the number of countries involved. Like other central bank issued digital currency projects, while there may be potential benefits such as increases in the efficiency, and reductions in the cost, of capital allocation in the economy (Keister & Sanches, 2019), there are also likely concerns to be overcome regarding its potential impact on banks and the process of financial intermediation. For instance, central bank issued currencies could erode private banks' share of payments activity as well as customer deposits. As a result, this could impact the stability of bank funding and increase its costs with potential implications for bank performance and risk-taking, as well as system stability. Moreover, there are concerns that such effects may be amplified during periods of crisis and pose threats to the financial system (Kumhof & Noone, 2018).

Aside from the euro area, comprised of its nineteen-member states, a number of other countries have already experimented with digital versions of their currencies. Ecuador gained much interest for being the first country to do so in February 2015 when the Ecuadorian Central Bank (BCE) issued the dinero electrónico (DE). Yet, less than three years after its introduction, in late 2017 it was announced that the digital currency project would be closed with account holders given until March 2018

[2] To find out more and the Libra payment system and associated blockchain the white paper can be found here: https://www.diem.com/en-us/white-paper/#cover-letter.

[3] See https://www.bis.org/publ/work880.htm.

to withdraw their funds. The reason for its closure was cited as a lack of users or volume of payments. Even just one year after it was introduced, the Ecuadorean digital currency had fewer than 5000 users—well short of the half million users predicted by policy makers. However, in the case of Ecuador another major reason for its failure was almost certainty lingering issues trust in the Ecuadorian currency itself, which had been hit with problems with hyperinflation for much of the later part of the twentieth century and culminated in the US dollar replacing the sucre as fiat in March 2000. Sweden has also reaching the end of a one-year pilot scheme that began in February 2020 to test a digital form of currency called e-krona. A formal review of the potential to launch this digital currency fully is expected to be completed by November 2022. More recently, in October 2020, the national bank of Cambodia has introduced a central bank digital currency called Project Bakong, which was developed in collaboration with a Japanese Tokyo based fintech firm called SORAMITSU who specialize in blockchain technology. Bakong has so far gained support from financial institutions within the country and is said to facilitate fast and near instantaneous transactions using either the US dollar or the Cambodian Riel (KHR). In January 2021 the Bahamas went further than the above pilots, by officially launching a digital version of the Bahamian dollar with a fully integrated digital payments system architecture under its Project Sand Dollar initiated by the Central Bank of The Bahamas (CBOB). Lastly, as of 2021, there are a number of central bank digital currency trials currently running in addition to Cambodia including China, the Eastern Caribbean Currency Union, South Korea, and Sweden, while Ecuador, Ukraine and Uruguay have already completed pilots.

As previously noted in the introduction of this section, the idea of digital currency itself predates blockchain and distributed ledger technologies. However, these innovations are making the plausibility and feasibility of central bank issued digital currencies an increasingly likely and realistic proposition. This increased interest in central bank digital currencies is also evident in the number of speeches and reports by central banks that reference them as well as an examination of Google search trends.

There are a number of compelling arguments in favour of central bank issued digital currencies. First, as we highlighted earlier, cashless, or near cashless, economies are increasingly becoming the norm—driven by technological and consumer changes as well as governmental objectives. This means that physical cash is becoming scarcer in many countries, with digital banking and electronic payments becoming more and more popular—even for small purchases. Second, cryptocurrencies are still in an embryonic state and as we discuss within this chapter when, or even, whether they might serve as generally accepted digital currencies is of still much debate. In contrast major world currencies such as the US dollar, Yen, and Euro issued by central bank currencies are generally well understood and trusted despite their centralized nature. Moreover, from the perspective of government and central banks' the growth of cryptocurrencies and projects like Facebook's Diem blockchain and Libra cryptocurrency have raised concerns regarding loss of control over payments system, currency, and ultimately economies. The implementation of central bank digital currencies may therefore be viewed as helping to mitigate privately led competition and serve to strengthen monetary sovereignty (Brunnermeier et al., 2019). Third, a central bank digital currency could improve the effectiveness of monetary policy. For example, a central bank digital currency could affect the market for consumer deposits—especially if traditional bank deposits and central bank digital currency represented near substitutes this would potentially increase competition and make monetary policy a more sensitive tool. Finally, the real-time settlement of functionality of a central bank digital currency could offer a viable alternative digital payment channel to ensure money is transferred quickly towards where it is needed. The importance of this has been highlighted by the current COVID-19 pandemic.

In terms of the implementation of central bank issued currencies, an important distinction can be made between account-based and token-based systems. Central bank issued digital currency could be held centrally on a central bank account or could alternatively be based on tokens (e.g., coins) (Kahn et al., 2019). This would have implications for who would be held liable for fraudulent transactions, since account-based systems require identifying the payer, whereas in a token-based system there is the requirement to establish the validity of the object used to pay. To better illustrate this difference, consider a simple purchase of a bagel in a token-based system. If the purchaser pays for their bagel with currency the merchant need only check that the currency used is valid. In contrast, under an account-based system the purchase could involve a payment form such as a debit card. In this case there is also a need to verify identity of the account holder rather than simply whether the token received is valid or counterfeit. Furthermore, under an accounts-based payment system accounts aggregate funds in one central location. This centralized storage means that security is especially important when an account is accessed since all funds are at risk. Conversely, since funds are not necessarily centralized with tokens, any separately stored funds are not exposed to the same level of risk from one access point. Finally, it is important to note that a central bank digital currency could actually incorporate aspects of both account- and token-based systems such as the central bank digital currency experiment by the Uruguayan central bank in 2018.

A second distinction can also be made between single- and two-tier distribution systems. Under a single-tier system distribution of the digital currency is from the central bank who offer direct competition to private banks for consumer deposits. As our brief discussion in this section has already highlighted, this competition could have implications for the supply of credit and financial services in the economy which may pose threats to the ongoing importance of private banks in the financial system. Conversely greater central bank power in a single-system may have positive implications for the precision and effectiveness of monetary policy. In contrast, a two-tier system would allow for digital currency to be issued by private institutions such as banks. Such a system would be more comparable to the existing banking system.

4.4 Cryptocurrencies and Blockchain: Country Responses

In addition to digital money and central bank issued digital currencies, countries are also encouraging experiments with blockchain technology—and to lesser extent cryptocurrencies—for myriad potential applications that may be economically and/or socially valuable. While most countries seem generally keen to explore these innovations they also remain quite cautious, and especially so with respect to cryptocurrencies. This prevailing view is well encapsulated in 2018 comments by Singapore's Deputy Prime Minister Tharman Shanmugaratnam who stated '*we will continue to encourage experiments in the blockchain space that may involve the use of cryptocurrencies. Some of these innovations could turn out to be economically or socially useful. But equally, we will stay alert to new risks*'.[4]

[4] See https://www.mas.gov.sg/news/parliamentary-replies/2018/reply-to-parliamentary-question-on-banning-the-trading-of-bitcoin-currency-or-cryptocurrency.

It is evident much uncertainty still surrounds the adoption of cryptocurrencies. Regulators worldwide have expressed both excitement and concern at the potential for cryptocurrencies and blockchain technologies. On one hand, technological innovations including blockchain technologies have huge potential to be utalised as the bases to derive substantial benefits to societies and economies. On the other hand, and by way of example, concern by US regulators over cryptocurrency markets have led to the passaging of the Virtual Currency Consumer Protection Act of 2018 and the US Virtual Currency Market and Regulatory Competitiveness Act of the same year. While in the UK, the Financial Conduct Association's (FCA) Guidance generally treats cryptocurrencies as unregulated with some caveats relating to the underlying properties of the specific cryptocurrencies. More centralized cryptocurrencies and so-called 'stablecoins', whose value is pegged to an underlying reference asset, are more likely to be subject to regulation. However, this is not necessarily the case, and such decisions are currently made on a case-by-case basis. In other countries the regulatory treatment of cryptocurrencies is more explicit.

Although there is still no multilateral agreement as to how cryptocurrencies should be regulated worldwide, a seemingly shared concern amongst international regulatory bodies and governments are specific issues surrounding the potential use of cryptocurrencies to finance illegal activities and the lack of protection for consumers and investors. Similarly, a concern that if cryptocurrencies continue to gain importance as means of payment more regulation may be required. This view is reflected in the comments of the current Chairman of the Financial Stability Board, Randal Quarles, who expressed the following view to G20 leaders before the 2019 G20 summit: '*wider use of new types of crypto-assets for retail payment purposes would warrant close scrutiny by authorities to ensure that they are subject to high standards of regulation*' (Reuters, 2019). Indeed, how cryptocurrencies should be classified and regulated in the future has been the subject to much intense international debate, which has recently promulgated in a push to issue strong multilateral guidance to countries. Leading the way is the Financial Action Task Force (FATF) and their guidelines for best practice. First published in 1990 and subsequently revised in 1996, 2001, 2003, 2012, 2018, and 2020, the FATF provide a framework of measures for countries to adopt to address issues surrounding the use of money for money laundering, the financing of terrorist activities and illegal arms. Regarding cryptocurrencies, FATF guidelines help address difficulties associated with approaching regulation of digital currencies by offering clear guidance.

As noted previously, countries have generally been supportive of blockchain technologies than cryptocurrencies—stressing their potential to be socially and/or economically beneficial, yet warier of cryptocurrencies. At present cryptocurrencies have yet to become a widely accepted means of payments in virtually all countries. For example, in Argentina cryptocurrencies arguably do not currently fit with the definition of cryptocurrencies as digital money. Specifically, since cryptocurrencies are not currency currently issued by the central bank, they cannot be classified as legal tender. Despite not representing legal tender, cryptocurrencies such as Bitcoin have been quickly gaining popularity in Argentina for transactions. One important reason being that the government and central bank maintaining strict controls of the use of foreign currencies. A similar trend is evident in other countries, especially those prone to political, economic, and social instabilities. In many cases, cryptocurrencies are displacing traditional alternative assets such as gold for investors seeking refuge from unstable traditional fiat currencies.

Several countries have introduced partial or complete bans on their use. For example, China has banned the operation of both domestic (from 2017) and overseas cryptocurrencies (from 2018). The introduction of the ban in China was particularly significant since China had been estimated to be home to well over two-thirds of all cryptocurrency mining activity worldwide. The ban on cryptocurrencies in China also extends to initial coin offerings (ICO) and initially mining. The latter of which, the central bank of China, The People's Bank of China (PBoC), expressed particular concerns with in a public issued notice on September 18, 2018 where they articulated the view that ICOs represent vehicles for '*illegally selling [of] tokens, illegally issuing securities, illegal criminal activities, financial fraud, pyramid schemes and other illegal and criminal activities*'.[5] Although China has largely banned cryptocurrency use it is not a complete ban since cryptocurrencies are recognized as a being 'virtually commodity' yet they cannot be used to represent money in transactions. Moreover, despite initial plans to ban cryptocurrency mining in China, the country reversed these plans in 2019. Finally, the Chinese leadership have

[5] See http://shanghai.pbc.gov.cn/fzhshanghai/113571/3629984/index.html (in Mandarin).

repeatedly expressed their support for the use and growth of blockchain technologies.

In some respects, the lack of mainstream acceptance of cryptocurrencies as a means of payment makes the challenging task of regulation somewhat simpler. More specifically, since cryptocurrencies are (typically) private, decentralized and, it can be argued, lack intrinsic value, to be useful as a means of payment they normally have to be exchanged for fiat currencies. This process therefore renders them exposed to the prevailing financial sector regulation of the specific country and/or jurisdiction. Despite this they are increasingly being accepted as a method of payment and the news in February 2021 that Tesla Inc. has acquired $1.5bn USD of Bitcoin and plan to accept Bitcoin as a means of payment in the future could incite further growth of cryptocurrencies as accepted forms of payments. Also, in February 2021, European regulators have recently accounted new innovative/progressive rules to help stem the use of cryptocurrencies for illegal activities. In February 2021 the Europe Commission has just introduced its AML Action Plan which includes a specific requirement to report cryptocurrency-to-cryptocurrency transactions for the first time.

4.5 A Short History of Ledgers

Simply defined, a ledger is a book that provides a record of financial transactions or ownership of property or assets. Accounting ledgers have been employed for thousands of years. In fact, the first recorded ledgers date back 7000 years to the ancient Sumerians and the city of Mesopotamia (modern day Iraq), where ledgers were used to keep a record of trade. At first transactions were recorded by making 'impressions' next to pictorial representations of goods. These subsequently evolved by 3200 to become simple written records of transactions recorded on hardened clay. Progressing forward through history, the sophistication of ledgers naturally evolved. One of the most significant changes came in the 1300s with the emergence of the double-entry bookkeeping system. This system was quickly adopted within Europe—first by Italian merchants—historical records identifying its use in Genoa, Italy in 1340. However, it was perhaps best popularized subsequently by Benedetto Cotrugli in 1458. This innovative system, which forms the backbone of modern accounting, departs from single-entry bookkeeping systems in which every transaction is recorded in a linear list irrespective of whether it presents a credit or debit, to one in which debits and credits are recorded in separate 'columns', with debits recorded on the left-hand side and credits on the right. In this way every transaction affects at least two account so that total debts equal total credits, which gives rise to the fundamental accounting equation: Assets = Liabilities + Equity. The importance of the invention of double-entry book keeping has been the subject of much research, with scholars typically emphasizing its importance for economic development. For example, Nussbaum (1933, p. 159) states:

> *The significance of systematic bookkeeping for the development of capitalism, that is, for the rationalistic pursuit of unlimited profits, can hardly be exaggerated. …It reduced the idea of gain to an abstraction by putting the profit in a specific form, a definite sum of money in contrast to the natural aim of subsistence which was at the forefront of the medieval business man's mental attitude. It was this abstraction of profit that first made the concept of capital possible.*

An important concept, to which the double-entry bookkeeping system usually applies, is the general ledger. It represents a complete record of all previous credit and debit transactions within an organization organized by accounts or 'sub-ledgers'. Within the general ledger, these sub-ledgers record separate or running balances of an individual entity's financial position such that credit and debits balance. As such, general ledgers provide the data needed for modern organizations or individuals to provide accurate records of assets, liabilities, income, expenses, and capital and to generate key financial statements such as income statements and balance sheets.

As this section has outlined, ledgers have been in use for thousands of years and remain essential today. Aside from providing a means for individuals and organizations to keep accurate and complete financial records they represent an essential component of the global payment and remittance system. In particular, the global banking system has evolved so that for payments and remittance to take place organizations and individuals have to stake their trust in a centralized authority such as a bank. Similarly, financial assets are typically held within banking and other specialist financial institutions and service providers, who are in turn trusted to safeguard these on behalf of individuals and organizations. Considerable trust is therefore required to use the traditional banking system, given that the activities within are not directly observable to consumers. Such financial institutions and service providers typically keep private and centralized ledgers that record information of client accounts and of transactions that take place within the system. However, history has shown repeatedly that many problems—deliberately or accidentally—can arise which can serve to undermine trust and harm consumers.

So-called 'distributed ledger technologies' are beginning to address issues with the need for trust in the banking system, and have the potential to transform key areas. One area of particularly important is global payments and remittance, where new cryptocurrencies and associated blockchains are already offering viable alternatives as means of payment. Cryptocurrencies, and associated blockchain and distributed ledger technologies (DLT) are inciting considerable interest worldwide because of their potential to disrupt and/or displace longstanding processes and systems. Although they are not without controversy, they have exciting applications. One such area is in global payments and remittances. To understand how cryptocurrencies, blockchain, and DLT can disrupt such an important economic function, it is useful to briefly overview the current monetary and global payments landscape.

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Payment systems can be defined simply as the means, i.e. technology and processed, through which people and institutions transfer monetary value. This monetary value is typically represented in the contemporary payments system with money, which is exchanged for goods and services or to meet legal requirements. To be considered money an asset must satisfy at least several key functions. These should be accepted as a (1) *medium of exchange*, (2) *store of value*, and (3) *unit of account*.

1. Considering the first function, medium of exchange is a central tenant of money, and one stressed by classical and early neoclassical economists. It refers to the fact that an asset should be readily acceptable. Effectively this means that one should be confident that it will be accepted as a means of payment. The asset should also be

divisible, in that it can easily be separated and re-combined without affecting its intrinsic value—thereby allowing it to be useful as a means of payment for both small and large transactions. Moreover, its value should be high relative to its weight. Finally, it should be difficult to counterfeit, since this would undermine trust in its value and hence effectiveness as a medium of exchange.

2. To constitute money an asset should also represent an effective store of value, which closely relates to its value as medium of exchange. In other words, the asset should hold its value over time and not perish or depreciate, so that it can be effectively used for transactions today as well as at unspecified point in the future.
3. To function as an effective unit of account, an asset should also have a commonly accepted value and be fungible so that it is interchangeable. Examples include modern money forms such as bank notes but also commodities such as gold.

Prior to the invention of money, for transactions to take place required a 'double coincidence of wants' (Jevons, 1875). In other words, under a direct bartering system, for exchange to take place it required two parties to both have goods or services they were willing to exchange and also to fix a value for that exchange. This could be 1:1 but similarly could be any ratio. Aside from the difficulties associated with identifying and finding a counterparty to satisfy a double-coincidence of wants, establishing a value for exchange in the absence of commonly accepted, and widely known, asset values, is difficult. Another issue relates to 'portability'—i.e. the difficulties of physically transporting tangible assets. Similarly, there are at least several further problems with barter-based economies, which also indirectly contributed to the development of modern monetary forms. One issue relates to the fact goods or services bartered may not satisfy the condition of 'store of value'. Instead, they may be perishable, have to be consumed instantly, or simply depreciate over time.

As societies and economies evolved, the aforementioned issues with barter-based economies, led to the notion of 'ledger money', where simple ledgers were used containing arbitrary units of account as money. These could have been as simple as records of a favour to be redeemable at some point in the future. Furthermore, to the use of 'commodity money' where specific and desirable assets like grain or salt were used given their inherent intrinsic values. Yet although portable and divisible, such goods may be perishable, costly to extract, not always available, and not very portable. Eventually, specific assets such as gold and other precious metals began to increasingly be adopted as money. If we, for example, examine gold with reference to the three main properties outlined earlier in this section, we can see why it was widely adopted. First, gold is highly durable and almost indestructible. Second, it is also, dense, relatively portable, scarce, and costly to extract making it a useful store of value. Third, gold is valuable as a unit of account since it can be melted and reformed into different sized pieces—typically gold bullion—making it adaptable and flexible for use in different transactions. Similarly, and unlike other commodities such as diamonds, gold is highly interchangeable making its value largely a function of supply and demand forces. Interestingly however, unlike contemporary forms of money where the utility of money is determined by its objective exchange value, so that increasing its availability does not provide social benefit, gold has other applications including as an important component in the industrial manufacture of electronics. Such qualities meant that even when paper and coin-based forms of money displaced the direct use of gold or coins formed from high concentrations of precious metals, gold retained importance as a medium of exchange, store of value, and unit of account in the monetary system. In fact, for much of the nineteenth and twentieth centuries, where standard economic unit of accounts were based on fixed quantities of gold and money. For example, many major world currencies including the United States dollar and United Kingdom's sterling were backed by gold during this period.

For money to maintain its value and must be trusted by users. Yet for central government or country issued currencies, several things can occur that can destabilize its value. First, although not an issue with scarce commodities such as gold, governments could weaken the value of money by choosing to print or issue additional currency notes and coin physical or digital. They may do so for a variety of reasons including self-interest. For example, in the past governments and royals would often resort to printing additional currency to help finance wars. Similarly, the objectives of politicians and governmental may conflict with maintenance of stable money. History has repeatedly demonstrated that improper control over the supply of money can erode confidence and incite inflationary and hyperinflationary episodes. In fact, protracted periods of stable money have been infrequent in history. This highlights an important point, for money to be stable there must be sufficient trust in the issuer. Regional experiments in countries such as the United States, in which various decentralized authorities, namely banks, were permitted to issue money led to periods of instability where breakdowns in trust were frequent and culminated in financial panics and widespread bank failures.

Eventually, it was thought that adoption of more centralized means of controlling the supply of money would be advantageous in promoting money stability and a more efficient financial system. Growing acknowledgment of this fact, led to countries eventually establishing central banks as central authorities charged with the issuing and maintaining the stability of money, while being allowed to operate independently from governments and country leaders. In the United States such reasoning led to the establishment of the Federal Reserve System. Other countries such as the United Kingdom similarly established and enacted laws making central banks the sole authority in charge of issuing money and granting them sufficient independence.

The establishment of independent central banks helped to promote monetary stability, and provided a platform for economic growth and world trade. Aside from central banks, private banks also play very important roles in modern economic systems as conduits through which central bank actions affect money supply, as intermediaries between surplus and deficit economic users and as facilitators of economic payments. Much like issuers of currency, considerable trust has to be placed in banks to fulfil these roles both individually and collectively as the banking system. For this reason, central banks also play an important role in supervising and monitoring banks as well playing an active role in ensuring the efficient operation of payment systems. Yet even today trust in the financial systems is quite low. Episodes such as the global financial crisis (GFC) of 2007–2009 and the conduct of banking institutions before and during the crisis resulted in breakdowns in trust in the banking system. For the interested researcher a useful indicator of the level of trust in the financial system and in banking institutions is provided by the Chicago Booth/Kellogg School Financial Trust Index compiled by Paola Sapienza and Luigi Zingales.

To participate in the banking system and use it to facilitate payment, users have to place trust in both money and that the payment will be processed swiftly and accurately. More specifically to be effective a payments system must satisfy the needs of key stakeholders. These include both for-profit and non-profit private and public organizations, as well as international regulators. From the perspective of regulators, an effective global payments system should be: reliable, responsive, and secure; promote innovation and be adaptable to evolving consumer needs; easy to access, encourage effective competition for payment services and be efficient and offer value to consumers. Whereas, for consumers, and in addition to these characteristics, the payments system should be fast (with simultaneous or near-simultaneous payments increasingly expected) and have low cost, and transparent.

In recent years, technological innovation, change in consumer preferences, and regulation are leading to changes in global payments. The erosion of trust in the current financial system, governments, and private banks has also coincided with the search for alternatives. The FinTech innovation has led to the rapid emergence of alternative financing channels such as growth in online direct peer-to-peer lending and crowd funding platforms, as well as the emergence of alternative payment systems such as those offered by cryptocurrencies and blockchain.

4.6 Centralized vs Decentralized Ledgers

Before we explore cryptocurrencies in further depth, it is worth drawing distinctions between centralized and decentralized ledgers. In the traditional banking system transactions are processed using a centralized ledger and require trust in third parties. In the regular banking system payments require trust to be placed in private bank and financial services payments providers. Such institutions records details of any transaction on private ledgers that detail the transaction histories and balances. A simple example of how payments work under this system would involve two individuals who wish to transfer money between one another. Both individuals hold bank accounts. Individual A wants to send £500 to Individual B. To do so individual A would instruct their bank or payments provider to send the funds to the bank account of Individual B. Financial Institution A would then initiate the transaction by transferring the funds to the bank of Individual B who in turn would credit Individual's B account with £500. However, there is the possibility of delays in the process, errors to occur or for the banks to act dishonestly for example. In the above process, the ledgers of these banks are typically kept private and cannot be transparently observed. Thus, considerable trust has to be placed in both individual private institutions and the payments system.

The previous example, which represents the traditional payments system, involves the use of centralized private ledgers. A counterpoint to this would be the use of a decentralized public ledger, where no trust is needed in third parties. This system is the foundation of blockchain technology, according to which all users on a blockchain each hold their own copy of a shared public ledger, which is distributed widely around the world. Rather than requiring trust in a specific institution or institutions to enact payments, users or 'nodes' on a blockchain network can become validators of transactions—with a consensus-based system helping ensure the accuracy and validity of transactions. This property plus the advanced use of cryptography and consensus algorithms helps ensure the smooth and effective function of blockchain networks and help safeguard against fraud and network attacks.

As we noted previously, cryptocurrencies represent a particular form of digital money, or 'currency'. While cryptocurrencies vary in a number of respects including consensus algorithms, the central premise is that, unlike traditional form of fiat money, transactions involving cryptocurrencies are recorded digitally on a distributed ledger. Although the term distributed ledger technology (DLT) and blockchain often seem to be used interchangeably they are similar but not the same thing. DLT refers to a digitalized system of storing multiple transactions records in multiple locations simultaneously, whereas Blockchain represents a specific adoption of DLT, and as such shares its main characteristics. More specifically, DLT represents an architecture encompassing various protocols that allow for transactions to be proposed, validated, and stored in a decentralized network where records are stored on computers in multiple locations, and synchronously, rather than in one centralized location. Therefore, DLT removes the requirement for a central authority, such as a bank, to be trusted by users for transactions to occur. In this way, DLT, and specific adoptions of DLT like blockchains, have the potential to lower the costs of transactions. Moreover, in principle such a system is more secure, because each 'node' on the network holds a copy of the ledger this makes it more challenging for attackers to modify or destroy records since an attack would have to be coordinated so that decentralized ledger records are simultaneously modified. The clear benefits from DLT are therefore for payment transactions but also for numerous applications where secure digital records may be valuable such as social security, intellectual, and physical property rights.

In addition to being distributed and decentralized, blockchains add notable cryptographic security features based on various consensus algorithms to ensure the distributed digital ledger is: (1) secure, so that all records are encrypted; (2) anonymous or pseudo-anonymous, so that the identity of users is protected; (3) immutable, so that records cannot be reversed or tampered with; (4) distributed, every user holds an identical copy of the ledger; (5) timestamped, recorded transactions are timestamped on individual blocks of the blockchain; (6) programmable, so adaptable to specific uses such as smart contracts in the case of Ethereum; and (7) unanimous, they require a consensus to be reached within the network to determine the validity of transactions. Finally, can be either permissioned (private) or permission-less (public) blockchains.

Permissioned blockchains represent private blockchains in which the decision as to who can participate in the system, execute consensus protocol and maintain the digital ledger is governed by owners of the system. In this way the central authority also controls the governance of the blockchain. Three of the best known permissioned blockchains are Ripple, R3 Corda, and Hyperledger Fabric. Aside from control over the network and participants, the main disadvantages are that they can never be truly decentralized, are not fully transparent, and that user anonymity is not as well maintained as under a permissionless system. Conversely, notable benefits of these blockchains include their efficiency in terms of scalability and transaction speed, the fact they can be either transparent or otherwise, and the fact they are providing the basis for fully customized networks that can be adapted to the need of specific organizations. Such blockchains are already seeing interesting users. Two examples of companies that have employed permissioned blockchains are Walmart and Honeywell Aerospace who have built blockchains based on Hyperledger Fabric. In the case of Walmart, the application of the technology has been to trace the provenance of their products and ensure transparency in the food supply chain, while Honeywell Aerospace have developed an online marketplace for the buying and selling of aircraft parts which utilizes the blockchain to mitigate the issue of trust in transactions and to increase market efficiency. Separately, the diamond company De Beers who have employed the Tracr blockchain to establish the provenance and authenticity of their diamonds.

In contrast, permission-less blockchains do not require the permission of a central authority to join and contribute to the network. They are designed to be open and decentralized, whereby anyone can join the network and act as a reader and writer. The first example of this form of blockchain is the Bitcoin Blockchain, which allowed users to transact with the cryptocurrency Bitcoin. Another well-known example of a permission-less blockchain is the Ethereum blockchain. This blockchain has seen notable use as a platform for the development of 'smart contracts'. Smart contracts are secure digitalized contracts that are executed as programs on the Ethereum blockchain. These can have various feature just like traditional contracts, however, certain actions can be automated so that they are executed by the program, if, for example, certain contractional conditions are met or breached. Moreover, use of the blockchain adds valuable features as outlined in the beginning of this section.

If we take the example of Bitcoin and the associated Bitcoin blockchain, the underlying idea behind its introduction was to provide a system whereby users could transact and accept payments directly without the need to place 'trust' in a central entity such as a bank to complete transactions. As such, Bitcoin represents a digital currency that allows for financial transactions to take place directly between peers without the involvement of banks to act as intermediaries in the payments system. As such, cryptocurrencies based on blockchain technologies have the potential to drastically increase the efficiency and speed of transactions while lowering costs. Consider the process of a typical credit card transaction. To process a transaction, this would typically involve at least five separate organizations including the credit card company, two banks, a payment processor, and a clearing house. The process would typically go as follows: a buyer wishing to make a purchase would first need for it to be authorized by the merchant's Point of Sale (POS) terminal. The POS would check the card is valid and that the buyer has sufficient funds available to complete the transaction. Assuming the transaction is approved, no money would actually be transferred between buyer and seller's bank accounts at this point, instead the payment would simply be marked as being 'pending' on the buyer's account. At the end of the business day the merchant would then send all completed sales as a batch to be processed by their payment processor. This organization will then formally request the funds from the buyer's bank and at this stage this bank would clear the transfer of funds to the merchant's bank account. For a credit card this might occur within days and within four days for a debit card transaction. Clearly, this process is not very efficient in either time or cost. In contrast a transaction involving cryptocurrency and blockchain can be completed directly peer-to-peer using a fully digitalized electronic verification process that has three basic settlement steps. First, the buyer would select cryptocurrency at POS, this transaction would then be sent to a 'mempool' (a holding area for transaction awaiting validation) to be validated by a blockchain validator who verifies the legitimacy of the transaction. Once validated the transaction will eventually be added to the blockchain as part of a new block following with the order of transactions determined by a consensus protocol. At this point, the transaction will be completed with funds being transferred between the cryptocurrency wallets of the buyer and seller. Effectively this means that a transaction can be completed in an hour, minutes, or even mere seconds depending on the specific cryptocurrency and blockchain used.

4.7 Cryptocurrencies as Fiat And as an Accepted Form of Payment

There is much debate as to whether cryptocurrencies will ever be accepted as true fiat. Cryptocurrencies were originally conceived as decentralized digital cash systems that utilized advanced cryptographic features to establish security of transactions. Their emerging importance has induced much debate as to whether they may displace national fiat currencies in terms of worldwide importance.

Theoretically for a cryptocurrency to be considered as fiat it should possess certain properties. Specifically, it should be accepted as a means of payment, exchange, store of value, and a unit of account. Moreover, it should be infinitely divisible, transferable, durable, fungible, and be artificially scarce. Whether any cryptocurrencies currently meet these conditions is debatable. Take Bitcoin, while its use as alternative means of payment compared to traditional fiat currencies is now well established, with major international companies such as Microsoft, Paypal, Dell, Starbucks accepting payments using Bitcoin, its use as a store of value is more questionable. Indeed, many cryptocurrencies including Bitcoin have exhibited extreme price volatility to date. This property may make such cryptocurrencies attractive propositions for investors and speculators seeking to diversify investment portfolios, but a poor one as a store of value (King & Koutmos, 2021). It is also worthwhile to note that although 'store of value' is an important characteristic of money, not all traditional non-digital currencies have performed well in this respect, with numerous examples even if we only consider the twenty-first century. These include, but are not limited to, ongoing hyperinflation in Venezuela since 2016 and ongoing hyperinflation in Zimbabwe since 2007. Similarly, Argentina for much of the twenty-first century, which has included events such as the 2001 freeze on bank deposits in response to bank runs and withdrawal of International Monetary Fund (IMF) support and most recently governmental default on its debt in May 2020.

Aside from being legal fiat, the adoption of cryptocurrencies as a means of regular payment has yet to really achieve mainstream acceptance by consumers and businesses. Probable reasons for this, include the high volatility which is common to many cryptocurrencies, a lack of understanding as to how cryptocurrencies and blockchain technologies work and how to use them, and various regulatory and technical concerns surrounding their adoption. Some proponents of cryptocurrencies argue that in the future, some major cryptocurrencies will achieve a goal of price stability, which will render them more attractive as a store of value and means of payment, however, as of writing in 2021, we are a long way from such a point, and most cryptocurrencies are more analogous to commodities than alternative fiat. One thing is clear however, is that cryptocurrencies like Bitcoin have gained the attention of influential individuals. For example, Elon Musk the technology entrepreneur and Chief Executive Officer (CEO) of Tesla Inc has repeatedly publicized his support for Bitcoin and claimed to own a small 0.25 Bitcoin stake in May 2020. This support increased dramatically in 2021 when Tesla Inc revealed it had acquired $1.5bn USD of Bitcoin and stated it would likely accept Bitcoin as a means of payment in the future. The price of Bitcoin jumped approximately 20% in response.

The current instability of cryptocurrencies such as Bitcoin, which limit their attractiveness as potential fiat, has indirectly led to the emergence of a specific type of cryptocurrencies that aim to address some of the major issues with cryptocurrencies to date, in order to position themselves as viable alternatives to traditional fiat. This class of cryptocurrencies is referred to as 'stablecoins'. The first type, and simplest form, are fiat-collateralized stablecoins. These make up the majority of popular stablecoins and by design are centralized, which is therefore not consistent with the objective of many cryptocurrencies such as Bitcoin to be decentralized. Their value is pegged against a reserved fiat value such as the US dollar. Salient examples include USD Coin (USDC), Paxos Standard (PAX), Binance USD (BUSD), and Tether (USDT). Many of these have experienced very significant growth in popularity since 2020 for example, the market capitalization of Binance USD (BUSD) has grown by 8907.57% from $16,423,929 USD to $1,479,396,556 USD. Similarly, Tether (USDT) has increased by 472.66% from $4,648,319,510 USD to $26, 618,984,670 USD over the same period. Despite their growth they have not been without controversy. For instance, one of the most popular Tether (USDT) garnered much attention in 2018 when Ifinex (BFXNA Inc., BFXWW Inc., and iFinex Inc), was subjected to formal investigation by the Office of the New York Attorney General (NYAG) under the Martin Act (a New York state anti-fraud law), over serious concerns regarding the ability to convert Tether at its 1:1 pegged value to the US dollar. Furthermore, in 2019 persecuted found sufficient evidence to allege the company had tried to obscure a $850 million USD loss using a large Tether loan. This case was recently settled in March 2021, with Bifinex receiving a $18.5 million USD fine and both Bitfinex and Tether banned from operating in New York.

In recent years there has been much development in the area of stablecoins and there are now new forms of stablecoins that seek to combine the price stability properties of major fiat currencies such as the US dollar and commodities like gold, with the advantages of decentralized and distributed cryptocurrencies such as Bitcoin. These can be classified according to one of three types:

- Commodity-collateralized stablecoins: Instead of fiat, commodity-collateralized stablecoins are backed by commodities. Most often gold, but also real estate, oil, and baskets of various precious metals. Commodities backing these stablecoins are usually stories in a third-party vault. Examples of commodity-collateralized stablecoins include Tiberius Coin (TCX), Digix Gold (DGX), SwissRealCoin (SRC), HelloGold, and Digix Global.
- Crypto-collateralized stablecoins: These are tokens backed by a combination of other digital currencies. To account for the volatility of cryptocurrencies these stablecoins are overcollateralized typically by two or three tokens to a stablecoin so that even if there is price movement in backing cryptocurrencies under moderate amounts of volatility crypto-collateralized stablecoins can maintain price stability. Examples of crypto-collateralized stablecoins include Dai (DAI), bitUSD (BitUSD), and Havven (nUSD and HAV).
- Hybrid stablecoins: These stablecoins combine the categories above and as such are backed by various baskets of fiat currencies, cryptocurrencies, and commodities. They are typically collateralized or pegged against fiat first before various cryptocurrencies and commodities are added subsequently using an off-chain tokenized collateral. Examples of hybrid stablecoins include Aurora-Boreal

and Reserve. Another example was Sögur but this project was closed recently on the 5 January 2021 with the project team citing specific challenges associated with evolving, and uncertain, regulations worldwide.

- Algorithmic non-collateralized stablecoins: This category of stablecoins represents tokens where supply is determined deterministically using an algorithm that adjust currency supply in response to market forces to achieve a specific price target. Therefore, unlike other forms of stablecoin no tangible asset is required. Similarly, this category of stablecoin has more in common with traditional cryptocurrencies in that network are more decentralized. To date, the demand for algorithmic non-collateralized stablecoins has arguably been largely driven by market sentiment and momentum. Examples include Basis, Fragments, Carbon, and Kowala.

Dai attracted the attention of the participants of cryptocurrency markets not only because it was the first crypto-collateralized stablecoin, but also because it is credited to be the first application of Decentralised Finance (DeFi). The common object of decentralized finance applications is to create an open-source, transparent financial service ecosystem where users operate without any need of intermediation. Our current financial system heavily relies on intermediaries such as banks, insurances, and finance companies. DeFi applications are built upon the idea that smart contracts can conclude transactions without the need of intermediaries. Smart contracts can in fact specify the outcome of a transaction in many different scenarios and execute specific actions when one of the predicted scenarios realizes. Thus, the resolution of smart contracts does not rely on intermediaries or central authorities to enforce the terms of the contract. The contract is automatically executed in specific circumstances and its terms cannot be violated. The nodes of the blockchain ensure that the outcome of a transaction requested by a smart contract is in line with the terms of the contract. Each transaction is then validated and recorded on the blockchain following one of the consensus algorithms discussed earlier in this chapter. The absence of any intermediation is the key element of Decentralized Finance which aims at improving the efficiency of our financial system by reducing transaction costs and the need to put the burden of trust on specific entities in the system. DeFi applications also aim at enhancing transparency of the financial system as all the transactions finalized by smart contracts are publicly available for online consultation on a blockchain explorer.[6]

DeFi applications allow users to conclude essential financial operations such as borrowing and lending directly without the intervention of intermediaries. As mentioned earlier one of the first instances created was the MakerDao protocol. In this platform, users can borrow DAI a crypto-collateralized stablecoin pegged to the US dollar by pledging ETHs as collateral. The code embedded in the underlying smart contract ensures that the collateral is automatically liquidated if its market value falls below a prespecified threshold. This application was initially created to provide users with a decentralized stablecoin but it proved the potential of smart contracts and gave rise to a plethora of applications that later on were grouped under the name of Decentralised Finance.

Providing a strict definition of Decentralised Finance is difficult since new ideas and applications are proposed and discussed every day by programmers, investors, and enthusiasts. As today, the consensus seems to be that DeFi applications can be grouped in five subcategories: lending, decentralized exchanges (DEXes), payments, and investments. Among those categories lending and decentralized exchanges are by far the two most important categories. The total value locked in these two kinds of applications alone exceeds $15B. DeFi applications become increasingly popular since the summer of 2020 and their popularity spiked during the first months of 2021 reaching its peak in February 2021. In the lending market, this growth was mainly driven by 3 protocols: MakerDao, Compound, and Aave. These three applications are all based on lending and borrowing but each one has its own peculiarities. MakerDao is based on DAI a stable coin pegged to the US dollar that can be borrowed pledging enough ETHs as collateral. In Compound and Aave many different tokens can be pledged as collateral, but lending is always over-collateralized. Thus, for each dollar of collateral value locked in the applications users can borrow up to 75 cents depending on characteristics of the token used as collateral. One important difference between Compound and AAVE is that the latter offer 'flashloans' a form of borrowing that takes place only for the time of a single transaction on a blockchain. This is possible because in the Ethereum blockchain multiple actions can be performed in a single transaction. Hence, a user

[6] See https://etherscan.io/ for the Ethereum blockchain.

could borrow and repay a loan in the same transaction. The reason to perform such transaction lies mainly on arbitrages opportunities that may be available in the market for cryptocurrencies.

Decentralised exchanges are probably the most ambitious applications in the decentralized finance landscape. The main objective of these applications is to allow users to trade cryptocurrencies without the need of any intermediary such as centralized exchange or a clearinghouse. The common goal is to allow traders to buy and sell cryptocurrencies directly without the intervention of any intermediary. Since 2017 many different models for the creations of decentralized exchanges have been proposed. The early experiments relied on the classic order book mechanism. Unfortunately, while this mechanism works well in our current financial system, decentralized exchanges based on this model have failed to generate significant volume of transactions mainly due to inefficiencies in their design. In the cryptocurrencies space where all transactions completed by smart contracts need to be recorded on the blockchain order books are very expansive as transaction fees need to be paid each time users post, modify, or cancel an order. Thus, order books become an unviable option when the blockchain network gets congested and transaction fees inflate. More specifically, transaction costs could become very high in the Ethereum blockchain where most decentralized exchanges currently operate if the network is congested. It is worth noting that periods of network congestion correlate with high price swings that in turn may lead to high usage of exchanges. Hence, exchanges based on order books might not unusable exactly when they would be most needed. A more reliable solution to the decentralized exchange problem has been proposed by Uniswap.[7]

The funding idea of the Uniswap protocol is very simple. Each pair of token creates a liquidity pool. These pools contain reserves of both tokens in specific quantities. The exchange rate between the two cryptocurrencies is simply given by the number of tokens available in the reserves. When the amount of a token in the reserves decreases that token appreciates with respect to the other token in the pool and viceversa. Users can provide liquidity to each pool by adding both tokens to the reserves in specific proportion in order to leave the exchange rate unaltered. Liquidity providers are entitled of receiving fees based on the

[7] See Angeris et al. (2019) for a detailed discussion about Uniuswap protocol.

amount of liquidity provided to the pool but are exposed to losses when the exchange rate in the pool is not aligned with the market rate, offering arbitrage opportunities to traders. This very simple yet powerful model gave rise to two of the most important decentralized exchanges: Uniswap and Sushiswap that are based on exactly the same idea. The third most popular decentralized exchange at the moment is Curve that only allows users to exchange stablecoins and aims at offering very cheap and efficient transactions.

The last three categories of decentralized finance applications are not yet as popular lending protocols and decentralized exchanges. The amount of money locked in derivatives, payments, and investments applications together is still far below \$10B, measuring about \$7B at the beginning of 2021. In the derivative space the most popular application at present is Synthetic an assets issuance platform. In the payment applications the most popular one is Flexa, a platform that allows users to spend cryptocurrencies in their daily lives in United States and Canada. In the investment category the most popular application at present is Badger Dao, an application that allows users to optimize their returns and minimize their costs from holding assets whose value depends directly on the Bitcoin price.

Decentralized finance applications are very appealing from practical and theoretical standpoints. These applications can, in fact, potentially reduce frictions in financial markets. Nevertheless, these applications also raise relevant regulatory concerns. The most pressing issues are probably related to monetary policy. Since the financial crisis of 2008 central banks have extensively recurred to monetary policy to stimulate growth, the fact itself that private companies may issue tokens or coins pegged to specific currencies independently from monetary policy could represent an issue for regulators. Furthermore, policy concerns linked to decentralized finance are not limited to stablecoins. Issues related to the governance and taxation of the applications would also represent a concern for regulators. On September 2020, the European Commission disclosed a proposal for regulating markets and crypto-assets. This proposal aims at imposing on companies active in the cryptocurrencies market some requirements in terms of governance capital and disclosure. Regulating the decentralized Finance is very important as many users are probably shying away from the cryptocurrency market as they feel they would have no legal instruments to defend their selves should they deem it necessary. Thus, regulators may have the very delicate task ahead. They may be required to find a balance between a very strict and a loose regulatory action. From one perspective, very tight requirements could offer protection to DeFi users but could endanger the innovation process or generate very high incentives to elude regulatory restrictions. A very light touch, on the other end, could be at risk of being ineffective in ensuring the stability of the European financial system.

4.8 Consensus Algorithm Employed to Secure Network

As previously noted, cryptocurrencies are typically built on blockchain technologies and on distributed ledger technology. An important component in this system is the role played by 'validators'. Validators store records of previous transactions on the digital ledger as well as updating the ledger periodically to facilitate transaction settlement. This process of validation of new transactions, or transaction settlement, requires that a 'consensus' is reached amongst validators on the network. For example, in the case of Bitcoin over half the network of validators need to reach a consensus for new transactions to be added to the blockchain in the form of a new 'block'. This process helps to ensure the validity and accuracy of recorded data. Moreover, the use of cryptographic hash functions in the validation process further helps ensure the security of blockchain data. In addition, although many cryptocurrencies like Bitcoin are mined not all cryptocurrencies are mineable. With minable cryptocurrencies, mining is used as a means to introduce new cryptocurrency. Analogous to traditional mining of gold or gem stones, considerable effort has to be exerted by miners in the mining process. In the case of cryptocurrencies like Bitcoin the mining process involves the use of computing power to solve complicated numeric problem to verify new transactions. Miners are then rewarded, in the form of new cryptocurrency, for the process of completing 'blocks' of verified transactions which are then added to the existing blockchain.

Although individual cryptocurrency ecosystems differ in various ways, two key distinguishing aspects are whether a currency is mined or otherwise as well as the type of blockchain protocols employed, or in other words, consensus mechanisms used. Many major cryptocurrencies are backed by their own distinct blockchains including Bitcoin (BTC), Bitcoin Cash (BCH), Ether ETH), Ripple (ERP), Tether (USDt), Litecoin (LTC), EOS, and its EOS.IO blockchain protocol and Tezos (XTZ).

Although all blockchains and consensus algorithms differ, they all face something called the FLP Impossibility of Consensus (Fisher et al., 1985). Its three central tenants posit that security, liveness, and fault tolerance cannot be guaranteed in the same way as they would be under an asynchronous system. In different words, the FLP Impossibility of Consensus stresses the difficulty (impossibility) of achieving consensus within distributed systems. In essence, one key concern with decentralized systems is the difficulty associated with achieving a consensus amongst network nodes on the correct order of transactions, since different nodes may end up reaching different opinions. A consensus therefore needs to be reached for the system to function effectively.

However, at least several problems may occur that make reaching a consensus challenging. First, the Non-Blocking Atomic Commitment Problem relates to difficulties in establishing whether to commit or abort a particular transaction. Each node on the network has to independently make a vote of either 'no' or 'yes'. A vote of no infers that a node supports aborting the transaction, whereas a vote of yes would represent approval of the transaction. Crucially all nodes need to agree on the decision to establish 'validity' of the transaction. Failure, or 'termination', of the system would occur if nodes do not reach agreement. This difficulty in establishing both the validity of transactions as well reaching a system consensus amongst nodes is a well-recognized problem with distributed systems.

Second, State Machine Replication (SMR) systems capture the state of a system at specific point in time. They are a key concept in distributed computing for implementing fault tolerant systems. Such systems take in a set of commands, apply these commands in sequential order using a transition function, and use these to produce an updated system state. An example of a distributed SMR is the Bitcoin ledger. Under such a SMR distributed system, network nodes are meant to employ the same transition function. To ensure the view of the system's state is consistent there needs to be consensus regarding the current system state as well as the inputs employed to modify it. Since numerous requests may be made to the system, the ordering of these requests by network nodes is vital because inconsistent ordering between nodes would result in something called the log replication problem, which occurs when there is disagreement amongst nodes over the correct ordering of commands. In the case of the Bitcoin blockchain, the system state is comprised of public keys containing associated Unspent Transaction Outputs (UTXO) (i.e.

unspent 'satoshis' or fractions of Bitcoins). Commands that modify the state of the Bitcoin ledger (based on the transition function) represent valid Bitcoin transactions. However, the ordering of these transactions must be consistent across network nodes, since otherwise transactions marked valid by one node risk be invalidated by another.

Third, and relatedly, the synchronization of clocks between nodes is very important in establishing a common value of time between network nodes, which in turn is important for helping to establish network agreement regarding the correct ordering of transactions. Even locally minute differences in the recording of the passage of time, owning to clock drift, can have significant impacts, and therefore serve to undermine the effectiveness of the network. Thus, clocks have to be synchronized at regular time spaced intervals across network nodes. Finally, there are other failures that can occur. These include: 'crash failure', where nodes may fail to complete the execution of commands so that no, or only selected, information is shared with network nodes, 'omission failure', where information sent by a node is not received by others, and byzantine failure, which stems from the Byzantine Generals Problem (BGP), which we discuss in the context of the Byzantine Fault Tolerance (BFT) consensus algorithm later in this section.

Before we discuss the different protocols used to help achieve consensus, Table 4.1 presents a brief summary of the major features of the top-ten cryptocurrencies on CoinMarketCap as of January 2021.

Proof-of-Work (PoW): This is the most widely known consensus algorithm used for verification of blockchain transactions. It is used by Bitcoin and has also been employed by Ethereum to date. Under this system nodes on a decentralized network are required to perform complex calculations that are computationally intensive. The idea is that although the set problems are computationally difficult and time-consuming to solve, the process of verification of the correct solution by the network is straightforward.

A classic example of a cryptocurrency that employs PoW to validate and order transactions is Bitcoin. In particular, Bitcoin employs something called the HashCash proof-of-work function. This function is based on 'HashCash', which was invented by Adam Black, a British cryptographer and now Chief Executive Officer (CEO) of Canadian blockchain company called Blockstream, in 1997. Originally intended as a means to help mitigate distributed denial-of-service attack (DDoS) over the Internet of Things (IoT) as well as to reduce spam emails, HashCash

Table 4.1 Features of the top 10 cryptocurrencies

Rank	*Began*	*Cryptocurrency*	*Consensus algorithm*	*Ledger*	*Total supply limited?*	*Stablecoin?*	*Directly mineable?*
1	2009	Bitcoin BTC	Proof-of-Work (PoW)	Bitcoin blockchain	Yes	No	Yes
2	2013	Ethereum (Ether) ETH	Proof-of-Work (PoW)/Proof-of-Stake (PoS)	Ethereum blockchain	No	No	Yes
3	2014	Tether USDT	Depends on blockchain	Blockchains including Bitcoin, Ethereum, EOS, Tron, Algorand, and OMG	No	Yes	Yes
4	2016	Polkadot DOT	Nominated proof-of-stake (NPoS)	Polkadot Relay Chain and numerous external blockchains	Yes	No	Yes
5	2012	RIPPLE XRP	Proof-of-Work (PoW)	XRP Ledger	Yes	No	No
6	2017	Cardano ADA	Proof-of-Stake (PoS)	Cardano blockchain	Yes	No	No
7	2011	Litecoin LTC	Proof-of-Work (PoW)	Litecoin blockchain	Yes	No	Yes
8	2017	Bitcoin Cash BCH	Proof-of-Work (PoW)	Bitcoin Cash blockchain	Yes	No	Yes
9	2017	Chainlink LINK	Not directly applicable	Not applicable (Chainlink oracle network)	Yes	No	Yes
10	2014	Stellar (Lumen) XLM	Not directly applicable	Steller blockchain	Yes	No	No

Source Compiled and tabulated by authors using data from CoinMarketCap is used in the Bitcoin mining process to validate and ensure the accuracy and security of transactions on the blockchain making it essential to the Bitcoin ecosystem.

A hashing algorithm itself is a mathematical function that condenses a string of any length into a fixed-length alphanumeric string. The idea is that data is transformed, or 'encrypted', into a secure format that cannot be read without the use of a unique key. In other words, even if data incepted it would be almost impossible for the hashed data to be transformed back into the original unencrypted data without the key. As part of the validation process, every transaction block on the Bitcoin blockchain is run through a consensus mechanism where a string is hashed using a specific cryptographic hash function (CHF) called Secure Hash Algorithm 256, or SHA-256, which creates values from the string using a mathematical function. A versatile hashing algorithm widely employed for website and email security applications, SHA-256 was invented by the US Government's National Security Agency (NSA) in 2001, and subsequently adopted by Bitcoin and the Bitcoin blockchain upon its inception in 2009. SHA-256 allows for the conversion of an 'input', a text string of unspecified length, into a fixed-length string output, known as a 'hash', containing 256 bits, or 32 bytes and displayed as 64 alphanumeric characters. This generated unique string then represents a mathematical problem for miners to solve using computational power. Once a correct solution has been identified and verified by the network a transaction is then 'confirmed' and a new block can be added to the blockchain. Unfortunately, compared to other consensus algorithms PoW protocols are not very efficient since they are slow and require large amounts of energy to maintain the distributed ledger. For instance, it takes about ten minutes to mine a Bitcoin block, which contrast with seconds for other protocols.

Proof-of-Stake (PoS): The proof-of-stake, or 'PoS', consensus algorithm differs significantly from PoW in that miners mine or 'validate' block transactions based on 'staking' their own cryptocurrency tokens. According to this system, participants stake a given number of units of cryptocurrency in order to fulfill the role of verifiers. Unlike mining-based systems like PoW, new blocks on the blockchain are not mined per se, but rather they are 'forged' and verifiers are known as 'forgers'. The majority of cryptocurrencies that use this consensus algorithm reward forgers who successfully verify transactions with a transaction fee.

An example of a blockchain that uses PoS is the Cardano blockchain. On the Cardano blockchain miners, or more accurately 'stakeholders', stake units of the underlying cryptocurrency called ADA and then Cardano's PoS system called Ouroboros selects a stakeholder through a randomized process to generate the next block on the blockchain. However, not all stakeholder will possess the necessary skill to generate a new block if selected. The solution is for stakeholders to combine their stakes in special stake pools run by stake pool operators who then take control of the production process when a stake they manage is selected by the Ouroboros algorithm. Rewards are then shared amongst all stake pool members. So in essence holders of ADA cryptocurrency can earn rewards by either running a stake pool or by delegating their stake to a stake pool.

Finally, PoS may be considered as holding two main advantages over PoW. First, PoW tends to require significant computational resources which in turn requires the use of large amounts of electricity and as such is not environmentally friendly. Secondly, the requirement to stake cryptocurrency act as a disincentive for miners to attack the network.

Delegated Proof-of-Stake (DPoS): Delegated Proof-of-Stake or 'DPoS' shares many parallels with PoS. The main feature that distinguishes DPoS from PoS is that stake pools are replaced with a system in which stakeholders vote democratically on who is responsible for producing new blocks. To add a malicious block to the blockchain a user would have to own 51% of all cryptocurrency on the network. This contrasts with PoW which would instead require a user to control more than 51% of computational power on the network. Analogous to shareholder voting rights, every stakeholder has voting power to influence this decision. However, not all individuals have the same degree of influence since a stakeholder's voting power is determined by the number of cryptocurrency units held. Decisions on who is responsible for producing new blocks is then based on considerations such as reputation within the network. Unlike miners under a PoW protocol miners are now rewarded for solving complex puzzles but instead receive a transaction fee for verifying transactions. Thus, the DPoS system can be viewed as largely self-governing. It also has the effect of increasing the efficiency of the ecosystem—yielding benefits in terms of speed, scalability, use of resources, and security. For example, it allows for transactions to be verified much more quickly than under PoW and PoS systems—with transactions verified in mere seconds. Moreover, undesirable activities are more likely to be addressed under this system, because block producers can be removed from the system based on the votes' preferences of stakeholders. Similarly, security is further enhanced since it would disproportionately expensive for a user to try and acquire the 51% of coins needed to control the network. In these respects, DPoS can be considered as a natural evolution to the PoS system.

Proof of Stake Time (PoST): This is another variant on Proof-of-Stake (PoS), which adds stronger incentives to the 'staking' process to facilitate efficient consensus forming and greater security, whereby the probability of staking increases with time. Effectively, this protocol incorporates a nonlinear proof function that identifies the fractions of active and inactive time for a given block and stake time starts to decline over time if nodes do not participate by staking for the next block.

Two examples of cryptocurrencies which employ this protocol are Peercoin and VeriCoin. For example, VeriCoin which has its own distinct blockchain based on PoS but works alongside a digital reserve called Verium which also has its own blockchain which employs PoST. VeriCoin integrates these two blockchains together to form a 'Binary-Chain' that aims to provide a fully secure and decentralized system that separates currency (VeriCoin) from commodity (Verium) to facilitate fast trustless payments.

Proof of Activity (PoAc): This consensus algorithm was first introduced in 2012, and incorporates elements of both PoW and PoS concepts. Like PoW miners compete to be the first to solve a computational puzzle and mine a block. However, at this point PoAc departs from the PoW protocol, since, unlike PoW, these blocks are simply block templates with header information that do not contain transactions. Once a new block template is generated by miners, who earn a reward for doing so, then PoAc adopts a PoS protocol, and the header information is used to select a random group of nodes to sign the block. For the block to be added to the blockchain each of the chosen validators needs to sign the block. However, if the block is not validated by the validators, then the next winning block is instead chosen and new nodes selected. The implementation of PoW and PoS protocols effectively means a more secure and decentralized network, since both 51% of computation 'hash' power and 51% of coins are required to attack the network. This protocol has not been adopted by many cryptocurrencies to date. Two examples are Decred and Espers.

Proof of Burn (PoB): This is another protocol that, like PoAc, PoS and DPoS, addresses some of the issues surrounding the significant use of electricity required under PoW. In fact, it is quite similar to the PoW protocol. According to PoB, validators have to contribute coins to validate transactions which are then 'burned' and cannot be recalled. Validators demonstrate their loyalty to the network by paying coins and the extent to which they can validate new blocks depends on how many coins then burn. Put simply, the mining power of nodes (users) depends on the number of coins they commit, with greater commitment increasing the likelihood that the node is selected to be the validator of the next block. In this way, the process of verifying transactions and creating new blocks on the blockchain does not require intensive computational resources and use of energy unlike the PoW protocol. In fact, the system does not require resources to mine other than the burned coins. It also holds some advantages over the DPoS protocol. One of the most significant, is that coins 'staked' under DPoS, are not immune from being stolen through hacking, whereas coins contributed and then burned under PoB are at much lower risk. A second benefit relates to the fact that PoB is designed to reward longer-term investment compared to DPoS. For instance, Slimcoin, offers both an immediate reward from being selected to verify a new block but also the possibility to receive blocks over long-time periods, which encourages long-term investments in the network. Other examples of cryptocurrencies that use this protocol include Factom and Counterparty. Conversely, PoB cryptocurrencies such as Counterparty still faced the issue of centralization that is a particular issue with Bitcoin and many other cryptocurrencies. The issue is that users with greater resources to 'burn', in the case of PoB, or 'stake' in the case of PoS, have greater mining power on the network.

Proof of Capacity/Proof of Space (PoSpace): One of the key features of PoSpace is that relies on the use of very low power and inexpensive hard drives and storage making the mining process far more efficient in the use of resources—namely electricity. Although with PoW hard drives are employed for their computational power and more power equates to improved mining ability, this is not the case with PoSpace. Instead, hard drives are a means of storage. PoSpace makes use of the same SHA256 algorithm as PoW, yet how miners mine differs. Specifically, the process allows users to use hard drive space (rather than power) to mine. The implementation is through an algorithm that makes use of two-step process according to which chunks of data called plots are generated through a process of repeatedly hashing public keys. The larger the amount of hard drive space held by a miner, the more likely it is they will be selected to mine the next block. This contrasts with PoW where computational power, not space, matters. Two examples of cryptocurrencies based on the PoSpace protocol are SpaceMint and Burst Coin.

Proof of Checkpoint **(PoC)**: This protocol combines elements of both PoW and PoS algorithms to add an additional layer of security that also helps mitigate a double-spending issue that may occur under PoS through attacks to the PoS system. Essentially PoS is the main algorithm used in the mining process but occasionally an additional 'checkpoint' is required based on PoW. One protocol build around PoC is Friendly Finality Gadget (FFG), which is being envisaged for the Ethereum 2.0 blockchain.

Proof-of-Physical-Address (PoPA) and Proof-of-Bank-Account (PoBA): These are two protocols that aim to address issues with validation of users' identities by implementing an additional layer of security, and hence trust within a network, that connects digital wallets to an individual's physical address or bank account. Although one could argue such protocols are against the spirit of blockchain, they may provide important in establishing greater confidence in cryptocurrencies and blockchains and may work to mitigate the use of cryptocurrencies to finance illegal activities for example. In addition to both PoPA protocols there are plans by ConsenSys to introduce other user verification protocols including proof of photo ID and proof of account ownership.

Proof of Importance (POI): This protocol shares many characteristics with PoS but employs alternative metrics to evaluate nodes on the network including clusters of activity, tokens staked, and net transfers. It works by employing network theory to establish a rating for each nodes' relative importance within the network. The objective is to try and promote economic activity by mitigating undesirable behaviours on a network which could occur under PoS, such as hoarding which could inflate proof of stake scores. The POI protocol was developed by NEM and is employed by the cryptocurrency and associated blockchain who both share the same name.

Proof of History (PoH): This protocol serves to address a particular challenge facing cryptocurrencies and blockchain and that is determining the precise moment an event occurred. The majority of blockchains approach this problem by requiring a network consensus to establish that time has passed and consequently the order of transactions. However, this process is not necessarily very efficient. PoH is interesting in that it does not require a network consensus to establish a historical record of events, instead validators each maintaining their own clock that observes the progression in time through the integration of a simple SHA-256, sequential-hashing verifiable delay function (VDF). As such, this process completely eliminates the need for consensus across a network to be reached, which can be subject to delays, in order to establish an order for block production. This concept is being used on the Solana blockchain.

Byzantine Fault Tolerance (BFT): Byzantine Fault Tolerance, or 'BFT', is a consensus algorithm that is capable of avoiding a particular class of failures that stem from something called the 'Byzantine Generals Problem', or 'Two Armies Problem'. This basic problem was first conceptualized in a 1975 paper titled: 'Some Constraints and Trade-offs in the Design of Network Communication' by Ekanadham and Huber. The problem can be portrayed in terms of several army generals who each command a division on the Byzantine army. The generals seek to attack and conquer an enemy city but, given strong enemy city defenses, for this to be successful all generals must coordinate their attacks so that all army divisions attack in unison. To coordinate the attack successfully the generals must agree on a common plan. An alternatively successful option, since it would minimize casualties, would be for all generals to decide to retreat. However, the only form of communication between the divisional generals is via messenger and potentially undermining a coordinated attack (or retreat), which is the fact that some, or all, the generals may choose to act in malicious ways. For example, traitors, who, for example, by messengers or generals, could act arbitrarily and decide to take an opposite course of action to an agreed plan so that a coordinated attack or retreat would be destined to fail. The takeaway from this is that in situations involving multiple parties they must coordinate to avoid failure, yet some actors may undermine coordination by disseminating inaccurate information, being corrupt or unreliable.

In the case of a BFT consensus algorithm the generals in our example represent validators on the network who propose and vote on the validity of transactions. They need to reach a consensus for new transactions to be included in a new block to be added to the blockchain. For new transactions to be verified it requires that less than one-third of the validators are 'Byzantine'. In other words, they act honestly in verifying transactions. On decentralized blockchains since validators operating on the system are fixed or 'predetermined', for the system to be effective it relies on users to hold trust in at least two-thirds of selected validators.

In addition to BFT, there are also similar consensus algorithms that share many of the same properties of BFT, but which also allow for greater flexibility in validator sets. One example, is Federated Byzantine agreement (FBA), which is employed by Stellar as the 'Stellar Consensus Protocol (SCP)'. Unlike BFT, any user is permitted to join the consensus process with no one user holding ultimate, or the majority of, responsibility for decision-making on the network. The system similarly works on trust with users involved in the consensus system 'voting' by selecting their own trusted nodes (i.e. those involved in the consensus system). Crucially, if all validators or 'nodes' fail to sufficiently agree by forming a consensus over transactions to be added then the entire network will cease operations until a consensus is found.

Another notable example is Verifiable Byzantine Fault Tolerance (VBFT), which is employed for the OnTology platform and combines PoS, Byzantine fault tolerance (BFT) protocols with verifiable random function (VRF), a special cryptographic process first introduced by Micali et al. (1999) as a function capable of generating deterministic and unique 'randomness' which can be verified independently later. Importantly VRF differs from other algorithms used to create digital signatures in that is far more deterministic, random, and less prone to malleability. These are all qualities that make it especially attractive to blockchain applications. By combining elements of PoS, BTF, and VIF, VBFT aims to address the risk of centralization, which could occur on BFT (and other algorithms), while exhibiting strong resistance to network attacks and high levels of scalability attributable to the efficiency of the consensus process.

4.9 Concluding Remarks

With the global financial crisis (GFC) still strong in peoples' memories cryptocurrencies emerged suddenly in 2009 with the introduction of Bitcoin and in just over a decade have grown to become a mainstream topic and a source of both fascination and of much debate. This growth in popularity has also coincided with rapid growth in the number of cryptocurrency and associated blockchain projects, which have various exciting potential applications within the financial sector and far beyond. Conversations on public transport now seem as likely to be peppered with discussions about cryptocurrencies as they are sport. As this chapter has shown, cryptocurrencies as well as digital money more broadly are already shaping the future of payment systems and the financial sector. What the end point in this exciting journey will be however remains unclear. Will central bank issued digital currencies become common? Will cryptocurrencies become a commonly accepted means of payments? The answers to these questions will have important ramifications for the future of economies. What is clear however is that this will be an exciting trip whatever the final destination will be. This chapter has not sought to answer these questions directly but instead has provided an overview of the exciting areas of digital money, payments and cryptocurrencies, including offering a primer of some of the main consensus algorithms employed by cryptocurrencies to date.

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CHAPTER 5

The Development of InsurTech in Europe and the Strategic Response of Incumbents

Ornella Ricci and Francesca Battaglia

5.1 Introduction

It is commonly accepted that a fourth industrial revolution in the form of technological innovation is affecting the insurance sector by changing its business model and enabling new ways of communication and information sharing. These technologies are based on tools like cloud computing, telematics, Internet of Things (IoT), mobile phones, blockchain technology, artificial intelligence/cognitive computing, and predictive modelling. This distinct branch, also known as InsurTech in common parlance, refers to any digital technology-driven innovation applied to the insurance sector (Chishti & Barberis, 2016; Mackenzie,

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2015; Nicoletti, 2017; OECD, 2017). It aims to address several issues currently faced by incumbents and to improve efficiency in underwriting, risk pooling and claims management.

The environmental framework in which the insurance sector operates is undergoing new challenges, due to the substantial changes in customer needs and demands and to the increasing use of new technologies, which enhance competition and erode profit margins, particularly from agile start-up entities. In such contexts, where faster offers, higher transparency and comparability, more personalized services, and simplified claims processes are considered the new success factors, the insurance sector is currently moving to digitize its value chain, despite insurance companies being traditionally slow innovators.

There are two main reasons for the lack of innovation in the insurance industry: (1) the complexity and the heavily regulated nature of this sector and (2) the profitability of incumbents that provides few incentives to change. This is based on the view that change is not warranted while the industry is doing well. However, this situation is rapidly changing, as the application of technology improves the traditional insurance business model efficiency in several respects. In customer engagement, the use of technology improves customer relationship management (CRM), price aggregation, digital claims processes and online policy purchasing. With Internet of Things (IoT), technology can provide insurers with new revenue areas by using vehicle telematics, environmental sensors, provenance, asset trading and home security. In the health industry, wearables, genetic data, chronic conditional management and preventive healthcare can modify the way in which insurers provide services to their clients. As for information security, technology can be used in areas such as claims fraud detection, cyber breach insurance, risk management and personal data storage. Moreover, by using data analytics, insurers can obtain risk mitigation, dynamic underwriting and personalized premium in real time. Smart contracts employ publicly known data automatically to trigger policy claim, thereby reducing claims processing costs and disputes. The new blockchain technology can provide transparent, responsive and irrefutable claims management process. Finally, P2P insurance allows family and friends to form groups of policyholders online. Those groups with low claims gain discount on policy premiums thereby minimizing moral hazard issues that are common in the industry.

Braun and Schreiber (2017) argue that Big Data analytics and Artificial Intelligence are some of the most promising innovations; these are discussed in further detail in below (Boxes 1 and 2). It is evident that digitalization is deeply modifying the financial and insurance ecosystem, affecting all the activities of the insurance value chain, from product development to pricing/underwriting, sales and distribution, policy and claims management, and asset and risk management (Eling & Lehmann, 2018). In this new technological scenario, every insurance market player operates in a new ecosystem where InsurTech start-ups are rapidly growing. The focus of these new market entrants has evolved from offering software solutions to activities that clearly compete with those of insurance companies and brokers (Braun & Schreiber, 2017).

The remainder of the chapter focuses on how these new technologies and entrants affect the insurance industry landscape, by causing strong changes for incumbents, upon corporate culture, products, processes and customer relationship. We also provide an empirical analysis on stock market reaction to the incumbents' investments in InsurTech start-ups.

Box 1: Big Data

According to the definition provided by the Financial Conduct Authority (FCA, 2016), Big data refers to the use of new or expanded datasets, also from unconventional sources such as social media. The expression also refers to the adoption of all technologies required to generate, collect and store these new forms of data; the use of advanced data processing techniques; the sophisticated analytical techniques such as predictive analytics; and the application of this data knowledge in business decisions and activities. In the same report, the FCA also identifies the main sources of Big data that insurers may be using, such as proprietary data, data acquired from third parties, social media data (e.g. consumer-specific data taken from Facebook or Twitter) and connected devices data (e.g. telematics devices used in motor, home or health telematics).

Big data affects insurance in several ways, the most widely of which is data analytics. The second is underwriting and pricing, with different views on how Big data could apply to them. For instance, firms could leverage on the wealth of such data to better target and understand consumer behaviour that could be applied to distribution and sales. Big data could also streamline claims handling and complaints. Referring to the pricing (the actual commercial decision to offer a policy at a certain premium level) and the risk classification, the advent of Big data has given rise to more efficient risk-based pricing since insurers can now leverage on new sources of information for understanding policyholders and for fine-tuning their risk classification. The main benefit deriving from more effective risk classification is the ability to cope with the adverse selection by marketing to low risk customers. Potential policyholders that are low risk may not want to pay for a price that reflects the wider population of the risk pool.

Nevertheless, a greater risk classification involves a number of risks. It may be socially beneficial to the extent that insurers succeed in bringing new, low risk entities or individuals into the overall risk pool, but if it results in exclusion or difficulty in obtaining a quote for a high-risk policyholder, this could result in sub-optimal market outcomes. Moreover, risk classification may require insurers inquiring about otherwise irrelevant information, such as credit score, genetic information and sexual orientation, thereby raising privacy concerns. If policyholders refuse to answer to such questions by affecting in this way the pricing or offering of a policy, or even higher premiums, this behaviour could invalidate the merit of risk classification.

Box 2: Artificial Intelligence

Artificial Intelligence (AI) encompasses all intelligent agents (computer systems) that have the capacity to learn, adapt and operate in dynamic and uncertain environments (Miailhe, 2018). To achieve this, smart systems use advanced algorithms that learn with every additional data record and continually adjust and enhance their predictions. It also includes machines that mimic cognitive functions associated with human minds, such as learning, perceiving, problem solving and reasoning to achieve this (Balasubramanian et al., 2018).

Machine learning is one of the main ways in which AI is being applied, with algorithms that can learn from examples and can improve their performance with more data over time (PwC, 2018). Common examples include Google search, which can be posed questions instead of simple search terms, and Amazon and Facebook site content, which can make recommendations and ads based on browsing history.

In the insurance industry, the adoption of AI could improve the efficiency of transactions and business processes in several ways. For example, as the OECD (2020) states that robo-advice has the ability of developing a financial plan addressing multiple goals, including retirement, protection needs, estate planning and health/long-term care coverage. Robo-advice offers privacy to customers who may feel more comfortable when discussing money matters. It is also being developed for investment management and, in particular, to provide quotes with automated advice and offerings calculated through algorithms. Automated advice could help people that do not have access to financial advice in a less expensive manner as compared to a human advisor. Insurance start-ups like Lemonade and PolicyGenius employ AI to promote their policy offerings, by simplifying and tailoring them to match the needs and financial situation of the policyholder. Several start-ups are introducing AI into their processes, and their success will affect the way the overall insurance industry integrates AI to its businesses as well. Although EIOPA's thematic review (EIOPA, 2019) states that big data analytics can help insurers to detect fraud, the greater rapidity connected to the use of AI can compromise the optional payment, as well as potentially being more prone to fraudulent claims (Ralph, 2019).

5.2 The New Insurance Landscape

Due to its fast and global spread, the current InsurTech ecosystem has become vast, heterogeneous and opaque with a constantly growing number of start-ups. Moreover, InsurTech activity does not rely on an isolated part of the insurance value chain. Instead, almost all stages of the incumbents' ecosystem are being targeted. It is a difficult task to delineate a precise taxonomy of the various InsurTech companies: irrespective of the selected unidimensional criteria used for classification, a number of practical examples show that the boundaries among different categories are not clear cut, complicating the screening of the InsurTech landscape to a large extent.

The Insurtech map of start-up bootcamp InsurTech (2015) provides a classification based on the idea that technology is likely to have the most significant impact on the following seven categories: (1) customer engagement, (2) regulation and the law, (3) wealth management, (4) data and analytics, (5) information security, (6) health, and (7) IoT. Although appealing, this classification is fuzzy, as many companies operate in two or more of the suggested segments. For instance, a start-up that offers software for health insurance could either be assigned to category (4) or (6).

Similarly, the classification provided by Venture Scanner (2016) comprises 14 different start-up groups, spanning from automotive to reinsurance. However, the main concern with this approach is that it lacks discriminatory power and might be even misleading for some firms. For example, according to this classification, the US start-up Metromile, a pay-per-use car insurance provider, would be allocated to the automotive category while the on-demand product insurance mobile app could be grouped into the product insurance category. Other classifications suffer from similar weaknesses, such as the one provided by CB Insights (2015) where many start-ups fit into more than one category.

The main concern related to the previous classifications is that they are exclusively based on products, insurance lines, or technologies and do not capture the core characteristics of a business model. In order to avoid this issue, Braun and Schreiber (2017) propose an InsurTech taxonomy taking into consideration the three dimensions "InsurTech categories", "business model patterns", and "roles in the insurance ecosystem" and based on the following nine categories: (1) comparison portals, (2) digital brokers, (3) insurance cross sellers (4) peer-to-peer insurance broker, (5) on-demand insurance, (6) digital insurers, (7) big data analytics and insurance, (8) internet of things, (9) blockchain and smart contracts.

Finally, there are some authors proposing a broader taxonomy, based on fewer categories, such as the one suggested by KPMG (2020), which consists of the following three groups: (1) enablers, (2) partners and (3) challengers. More specifically, enabler InsurTech provide B2B point solutions that are designed to improve an aspect of a carrier's value chain. Examples include using aerial imagery or data algorithms to improve the underwriting process; deploying digital platforms to help agents and brokers write more, and better, business; harnessing machine learning to read and manage policies to help carriers identify and understand their true policy-related risk; implementing AI-powers chatbots to provide "human-like" customer service when human representatives are not available; or installing telematics into customers' vehicles to enable actual driving behaviour to be incorporated into underwriting and claims. Partner InsurTechs typically go to market together with traditional carriers. InsurTech firm provides the technology platform on which a carrier can create a new insurance policy or product; the carrier underwrites the product, and the two companies take it to market. A variation of this is digital managing general agents (MGAs), where an InsurTech launches and operates a new insurance brand (e.g. one focused on small businesses or other niche market) and a traditional carrier underwrites the products and policies. Finally, challenger InsurTechs are new standalone, licensed insurance carriers in their own right, and they represent a growing segment in the InsurTech space. Challengers are often MGAs that decide they no longer want to rely on a carrier's capital, but instead underwrite their risk themselves and compete with insurers directly. These InsurTech companies may buy underwriting capabilities or acquire shell insurance companies that have licenses.

Irrespective of the proposed categorization of InsurTech start-ups, it is likely that many changes due to digitization will be quickened by new market players. Based on these aspects, many industry observers believe that some InsurTech start-ups have the potential to eventually disrupt the insurance market. Although in 2017 a study by the German Insurance Association underlines that there are yet no signs for a crowding out of incumbents due to the rapid evolution of the InsurTech sector, there is no doubt that only incumbents complying with the new scenario of accelerated innovation will succeed. A KPMG (2017) report identifies partnership building, in-house development, incubation and, depending on the specific setting, a multi-strategy approach, relying on partnerships between InsurTech start-ups and insurers (Wyman, 2016). The reason is that most InsurTech activities are currently focusing on distribution rather than risk carrying, by posing a threat to agents and brokers rather than insurance companies. Incumbents may benefit by learning digital customer centricity from the "pacemakers of digitization", while offering the start-ups secure revenues through the sale of their insurance products.

In general, this new technological scenario can give rise to different strategic approaches of traditional insurance companies, which, in turn, may also translate into different business models (Consob, 2018). Following a passive approach, incumbents do not monitor new technologies and operate with the traditional approach, which exposes them to a high risk of being crowded out by new market operators that seize financial digitalization opportunities more efficiently.

Another possible strategy is the internal dynamic approach, consisting of an "in-house development" of new ways of producing and offering financial services, through the adoption of new technologies (including platforms) and new (digital) distribution channels aimed at more effectively and efficiently responding to customer needs and achieving a competitive market positioning. Differently, if incumbents adopt a collaborative approach, they develop a partnership in the InsurTech sector to seek operational advantages and synergies and/or to reduce the number of their competitors. This approach may include different strategic choices, such as the acquisitions aimed at the inclusion of InsurTech companies within the group; joint ventures based on the participation of operators in a InsurTech initiative; partnerships aimed at benefiting from the collaboration of InsurTech companies or, conversely, at offering them support in the development of certain process phases and/or new services and distribution methods; outsourcing specialized service/activity to third parties. Outsourcing of some financial activities could also give rise to shadow banking since third party providers may not be regulated to the same extent, giving rise to regulatory concerns.

The strategic choice of the incumbents depends on a number of external and internal factors. Relevant external factors include the regulatory framework and the ability (and the speed) of InsurTech start-ups in intercepting financial needs of potential customers. With respect to the internal factors, we can consider the corporate culture, which is primarily expressed by governance and is also widespread in the operating structure, and the human and financial resources available for operational development and the investments needed to implement the chosen strategies. We emphasize that this factor is particularly critical for small insurance companies which often lack the resources necessary for technological innovation; they are particularly exposed to very high potential competition from FinTech platforms (P2P lending, crowdfunding, robo advisors, etc.), which make timely and low-cost offerings to retail customers, who are generally the elective reference segment of smaller financial intermediaries.

In general, the majority of entrants are more prone to adopt a collaborative strategy with the incumbent companies. On the other hand, the development of alliances with new competitors (such as InsurTech suppliers) allows the incumbents to take advantage of the expertise, dynamics and ways of doing business, which the insurance industry could not have developed.

Insurance companies use different selection parameters in order to select the InsurTech model in line with the strategic objectives set. Short- and medium-term evaluations are carried out by analysing the value added to the value chain, impact on consumers, the effect on business lines, ease of integration, opportunity costs deriving from the failure to collaborate and the modular nature of offers. Long-term evaluation, on the other hand, adds the analysis of market potential, the ability to generate profit over time, to meet regulations and to integrate into an ecosystem (Capgemini, 2019).

5.3 Measuring Market Reaction to Incumbents' Investments in InsurTech Start-Ups

To the best of our knowledge, there are no studies measuring the stock market reaction to the announcement of InsurTech deals. We can only find few empirical analyses applying an event study methodology and considering the impact on the market value of incumbent banks involved in FinTech alliances through majority/minority investments and contract-based alliances (Hornuf et al., 2020) or M&As (e.g. Dranev et al., 2019).[1]

As already outlined in Sect. 5.2, there are several possible strategic responses that can be pursued by incumbents facing the new insurance landscape, and one of the most viable choice is the collaboration approach. Following Cappiello (2020), it is possible to identify several forms of collaboration between traditional (re)insurance companies and InsurTech start-ups: direct investments or investments through venture capital funds; strategic partnerships aimed at outsourcing or improving some stages of the value chain; accelerators and business incubators; and acquisitions to obtain better control over technological innovation. We focus our attention on the first form of collaboration (i.e. direct investments or investments through venture capital funds) which is the most common model currently.

We draw information on InsurTech deals from CB Insights Quarterly InsurTech Briefings (a report resulting from the collaboration between Willis Re, Willis Towers Watson Insurance Consulting and Technology and CB Insights). We examine a time interval spanning from 2017Q1 to 2020Q3 and consider in our sample all deals involving a listed European (re)insurance company included among the EUROSTOXX600 components, regardless the location of the target. CB Insights provides data on the deal announcement date, the name of main involved investors, the type of investment, the name of the target company, the amount of financing raised in the deal and a brief description of the target's business.

[1] Dranev et al. (2019) and Hornuf et al. (2020) are both cross-country studies covering also Europe. There are also studies considering one single country (e.g., Takeda et al. [2021] dealing with the Japanese case).

Since the information on the deal announcement date is of the utmost importance to run an event study, we double-check all dates using another source, i.e. Crunchbase Pro. We drop all deals not resulting both in CB Insights reports and in Crunchbase Pro. Furthermore, we also consider whether the (re)insurance company is the lead investor or not in the deal. And finally, we also collect data on the target company regarding: headquarters location, number of employees, revenue range and date of foundation.

In order to measure the stock price reaction for European (re)insurance companies involved in InsurTech transactions, we estimate abnormal returns (ARs) using a standard market model (MacKinlay, 1997), with a 250-day estimation period, ending 20 days before the announcement. Stock price series for the involved (re)insurance companies are obtained from Datastream, considering daily closing price. To represent the market portfolio, we use both a broad index at the European level (i.e. the MSCI Europe) and at the country level (i.e. MSCI France, MSCI Germany, MSCI Netherlands, MSCI Switzerland and MSCI UK).

Following Hornuf et al. (2020) we first focus on short event windows around the announcement date: (−1; 0); (0; + 1); (−1 +; + 1). And second, following previous studies on strategic alliances (e.g. Amici et al., 2013) we consider that the event may be either anticipated by investors and/or that the stock reaction may last more days: accordingly, we also define longer symmetric event windows: (−3; + 3), (−5; + 5), (−10; + 10), and (−15; + 15). For each event window, Cumulated Abnormal Returns (CARs) are obtained summing ARs for all days of the window; in addition, CARs can be aggregated on a cross sectional basis for a portfolio of N firms with the same characteristics (e.g. all firms realizing a certain type of deal). In this case, we calculate Cumulative Average Abnormal Return (CAARs) as the sum of CARs in a certain window for a group of N firms. After the calculation of CAARs, we test their significance using the Boehmer et al. (1991) test statistic with the adjustment suggested by Kolari and Pynnönnen (2010) in order to consider possible cross-sectional correlation among abnormal returns.

5.3.1 Descriptive Statistics

Overall, we have 154 deals for which we find information in both our sources of data (CB Insights and Crunchbase Pro). There is no evidence of clustering over time: 40 deals in 2017, 43 both in 2018 and 2019, and

Table 5.1 European (re)insurance companies involved in InsurTech transactions

Investor company	*Country of investor*	*Number of deals*
AXA SA	France	43
Allianz SE	Germany	42
Munich Re AG	Germany	30
Aviva PLC	United Kingdom	14
CNP Assurances SA	France	8
Aegon NV	Netherlands	5
Swiss Re AG	Switzerland	4
Direct Line Insurance Group PLC	United Kingdom	3
Zurich Insurance Group AG	Switzerland	2
Hannover Rueck SE	Germany	1
Helvetia Holding AG	Switzerland	1
Phoenix Group Holdings PLC	United Kingdom	1

Source Our elaboration on CB Insights and Crunchbase data

28 in 2020, where we have data on three quarters due to data collection constraints and overlap with the Covid pandemic crisis.[2]

First, we consider information on traditional (re)insurance companies involved in these transactions. In our final sample, InsurTech and private technology transactions appear to be very concentrated, i.e. promoted by a small number of incumbents (12), as shown in Table 5.1.

We have deals initiated by 12 different insurance companies (of which 3 are professional reinsurers) and companies ranking in the first three positions (AXA, Allianz, and Munich Re) account for about 75% of deals.[3] Adding the fourth and the fifth positions (Aviva and CNP Assurance) almost 90% of transactions are covered. We do not show the level of concentration in terms of funding amount, since the cited data providers

[2] We believe it is still too early for assessing the impact of COVID-19 pandemic on InsurTech investments.

[3] When we collect deals from an insurance company, we also consider deals initiated by controlled companies specifically devoted to private equity and venture capital investments (for example, Axa Venture Partners).

publish information on the total size of the deal, generally involving many investors, but the exact amount invested by the insurance company in the target is not known. Nevertheless, the insurance company is the lead investor in the transaction in 67 deals (43.5% of the sample). In terms of the total size of the deal, the information is available for 146 out of 154 deals and it ranges between US$1.2 million and US$550 million, with a quite asymmetrical distribution (i.e. the mean is almost $41 million against a median of US$16 million). The biggest transaction is valued over $500 million, which is a Series C financing involving Munich RE and other investors. The target company is Babylon Health, a UK digital health service provider that combines AI technology with the medical expertise of humans, offering accessible and affordable medical advice via video consultations, phone calls or text messages.

CB Insights provides a brief description of the target company and a classification of the deal in three main clusters: Property and Casualty (P&C) InsurTech transactions, Life and Health (L&H) InsurTech transactions, and private technology investments. These categories are not mutually exclusive: for example, the US$100 million mega-round involving the US online insurance platform PolicyGenius and the French insurer AXA (through AXA Venture Partners) has been classified both as a P&C InsurTech transaction and as an investment in private technology. Overall, 43 deals are classified as P&C InsurTech, 16 as L&H InsurTech, and 133 as investment in private technology. This is consistent with the higher development of InsurTech in the non-life business, especially in the health and motor segments (Cappiello, 2020). There are no transactions classified as both P&C and L&H deals, while we have 26 transactions classified as both P&C InsurTech and private technology and 12 classified as both L&H InsurTech and private technology. In addition, we run a brief text analysis of the target description in order to verify whether the following keywords were present or not: "Analytics, Artificial Intelligence; Blockchain; Big Data; Cloud (computing, data, or security); Cyber (risk or security); Internet of Things, Machine Learning; Smart (contracts or cities), Wearables". These keywords represent the main disruptive innovations described in our introductory section and are those leading change in the industry. These keywords are present in 54 deals.

In terms of geographical distribution, data reported in Table 5.2 shows that the United States is the country attracting more attention, where the target is located for about 45% of the deals. At a significant distance, we find the United Kingdom, France, and Germany.

Table 5.2 InsurTech transactions involving European (re)insurance companies—breakdown by target country

Target country	*Number of deals*
United States	69
United Kingdom	26
France	20
Germany	16
Canada	4
Switzerland	4
India	3
Israel	3
Singapore	3
Indonesia	2
China	1
Spain	1
The Netherlands	1
Uganda	1

Source Our elaboration on CB Insights and Crunchbase data

This suggests that a significant portion of InsurTech deals are cross-border in nature. In 35 domestic deals (around 23% of the sample), the insurance company finances a target located in its same European country while there are 33 cross-border transactions inside Europe (around 21% of the sample). Outside Europe, we find 73 cross-border transactions involving a target located in North America (United States and Canada) (around 47% of the sample); and 13 cross-border deals (about 8% of the sample) in which the target is located in other countries.

While from the standpoint of insurance companies involved as investors, InsurTech deals appear quite concentrated, there is a large variety of target companies. We find 111 different target companies involved, of which the vast majority (about 64%) was involved only in one deal, about a quarter in two deals, about 5% in three deals, and only one, i.e. Next Insurance,[4] in four deals.

What are the main features of the 111 target companies involved in these transactions? First, these companies are generally quite young, as shown in Fig. 5.1. There has been a fast growth in the number of InsurTech start-ups, especially after 2012. Target companies are also

[4] Next Insurance is a US based company providing an online insurance marketplace for small businesses and entrepreneurs, offering general liability, professional liability, workers' compensation and other types of insurance policies.

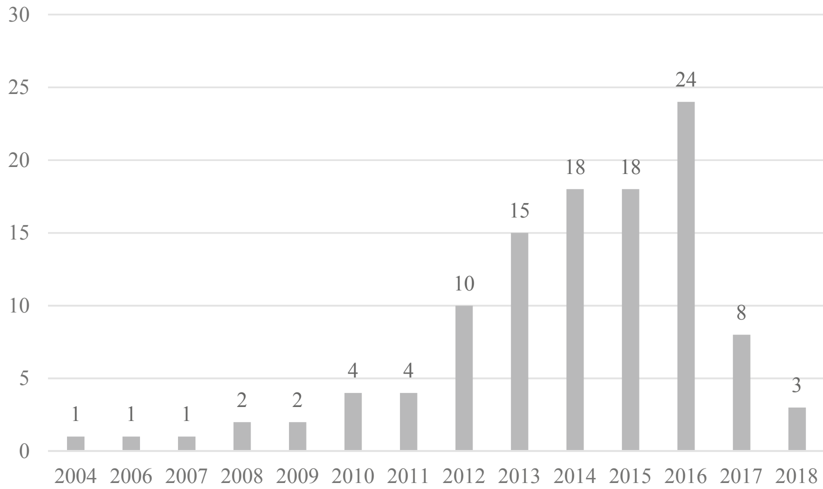

Fig. 5.1 Target companies involved in InsurTech transactions—year of foundation (*Source* Our elaboration on CB Insights and Crunchbase data)

generally small and medium size companies, considering both the annual revenue range (in million US$) and the number of employees. Almost 90% of companies are below the threshold of 50$ million and only 2 target companies are in the biggest cluster ($100M–$500M), both based in the United States: Policy Genius, an online insurance platform for unique, customized life insurance coverages, and Fundbox, a B2B payment and credit network.

Looking at the number of employees, majority of the firms are small and medium size entities: about 85% of target companies count less than 250 employees (Figs. 5.2 and 5.3).

5.3.2 Event-Study Results

Despite the fact that Covid pandemic had limited impact on the number of InsurTech deals, some considerations lead us to conclude in favour of the exclusion of 2020 deals from our event study. After the dramatic turmoil of March 2020, there was a notable rebound in financial markets over the summer, contrasting with weak economic fundamentals and increasing the risk of a correction (ECB Financial Stability Review,

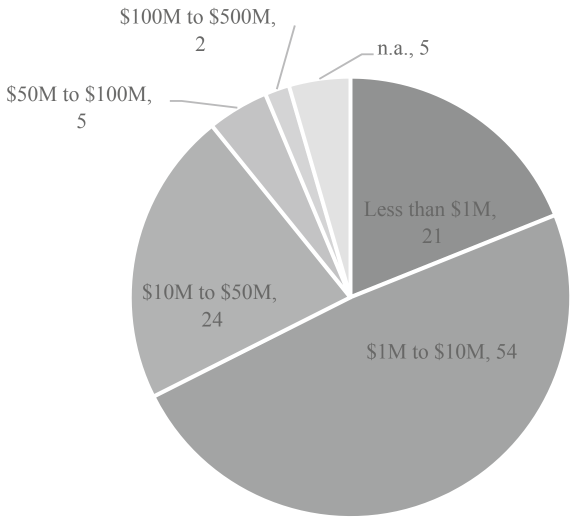

Fig. 5.2 Target companies involved in InsurTech transactions—revenue range (*Source* Our elaboration on CB Insights and Crunchbase data)

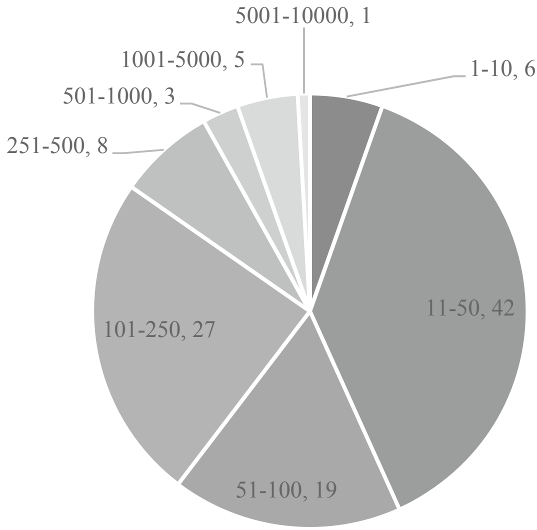

Fig. 5.3 Target companies involved in InsurTech transactions—Number of employees (*Source* Our elaboration on CB Insights and Crunchbase data)

November 2020b). In addition to the very high volatility for the entire stock market, it is also important to consider some specificities of the insurance sector, such as higher claims stemming from the pandemic and profitability pressures due to low-for-long interest rates.

In Fig. 5.4, we report the average value of daily log returns for the 12 (re)insurance companies involved in InsurTech deals over 2017–2020 (since our sample of InsurTech deals starts in 2017Q1 and ends in 2020Q3). It is evident than in March 2020 they experienced a strong turmoil, followed by very high volatility. For this reason, we prefer to limit our event study analysis to deals concluded over 2017–2019.

The main findings from our event study on the overall sample are reported in Table 5.3, Panel A. The only statistically significant result regards the CAAR in the longest event window (−15; + 15), which is only marginally significant (at the 10% confidence level) and is negative. To our knowledge, there are no previous empirical studies to compare our results with, dealing with very recent data and considering the InsurTech landscape. We further relate our results to the main findings of existing empirical studies based on a similar event study methodology, but dealing with FinTech in general, rather than with InsurTech.

Overall, InsurTech deals do not seem to increase shareholder value, which is at odds with our expectations. A first possible explanation is that these transactions, which are mostly investments in the form of private equity and venture capital, receive less attention by both media

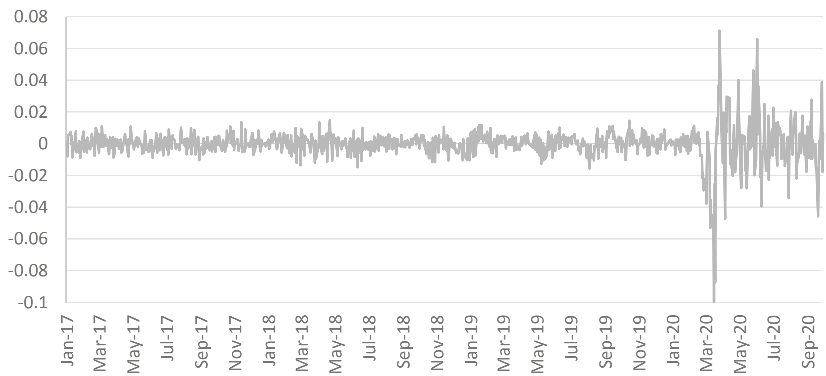

Fig. 5.4 Average stock returns of (re)insurance companies over the investigated period

Table 5.3 Cumulative average abnormal returns for InsurTechInsurTech deals

Panel A: Distribution by time

	Total sample, 126 obs					*Year 2017, 40 obs*					*Year 2018, 43 obs*					*Year 2019, 43 obs*				
	CAAR (%)	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*
(−1,1)	0.19	0.386	−5.15	5.93	50.00	0.11	0.822	−3.59	5.03	45.00	−0.15	0.657	−5.15	4.13	53.49	0.60	**0.090**	−4.56	5.93	51.16
(0,1)	0.06	0.869	−5.67	4.43	55.56	0.18	0.514	−3.78	4.43	55.00	−0.32	0.308	−5.67	2.79	55.81	0.33	0.169	−4.24	3.64	55.81
(−1,0)	0.19	0.321	−5.43	5.73	52.38	0.27	0.611	−2.43	5.73	50.00	−0.01	0.994	−5.43	3.04	51.16	0.31	0.248	−3.18	4.27	55.81
(−3,3)	0.26	0.353	−7.98	6.97	51.59	0.04	0.971	−4.84	6.53	52.50	−0.20	0.546	−7.94	6.52	39.53	0.93	**0.044**	−7.98	6.97	62.79
(−5,5)	0.02	0.898	−8.48	12.12	46.83	−0.12	0.625	−7.09	12.12	45.00	−0.47	0.342	−8.40	7.23	41.86	0.63	0.356	−8.48	12.00	53.49
(−10,0)	−0.09	0.664	−13.69	16.71	50.00	−0.34	0.488	−9.07	8.76	40.00	−1.58	**0.027**	−12.61	8.60	41.86	1.61	**0.099**	−13.69	16.71	67.44
(−15,15)	−0.75	**0.084**	−22.57	16.53	44.44	−1.04	**0.076**	−7.96	9.68	42.50	−2.86	**0.000**	−22.57	5.27	32.56	1.63	0.151	−13.69	16.53	58.14

Panel B.1: Geographical breakdown by country of the investor (Switzerland and Netherlands not reported for very small number of obs)

	FRANCE, 36 obs					*GERMANY, 63 obs*					*UK, 16 obs*				
	CAAR (%)	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*
(−1,1)	0.36	0.219	−4.70	4.91	58.33	0.04	0.915	−5.15	5.02	44.44	0.81	0.261	−3.59	5.93	56.25
(0,1)	0.01	0.897	−5.37	2.79	52.78	0.00	0.805	−5.37	4.16	55.56	0.67	0.240	−3.78	4.43	62.50

(continued)

Table 5.3 (continued)

Panel B.1: Geographical breakdown by country of the investor (Switzerland and Netherlands not reported for very small number of obs)

	FRANCE, 36 obs					GERMANY, 63 obs					UK, 16 obs				
	CAAR (%)	P-value	Min (%)	Max (%)	% Pos (%)	CAAR (%)	P-value	Min (%)	Max (%)	% Pos (%)	CAAR (%)	P-value	Min (%)	Max (%)	% Pos (%)
(−1,0)	0.18	0.352	−5.43	3.16	50.00	0.09	0.800	−2.64	4.85	55.56	0.72	0.229	−2.13	5.73	56.25
(−3,3)	1.17	**0.024**	−4.00	6.97	58.33	−0.13	0.423	−7.98	4.11	52.38	0.20	0.698	−4.84	5.83	37.50
(−5,5)	0.39	0.644	−7.78	12.12	44.44	−0.03	0.658	−8.40	6.21	49.21	−0.02	0.932	−5.70	12.00	43.75
(−10,10)	−0.23	0.845	−12.61	11.04	47.22	0.20	0.898	−10.25	8.76	55.56	0.86	0.549	−8.40	16.71	50.00
(−15,15)	−1.18	0.384	−22.57	14.60	47.22	−0.33	0.281	−12.55	9.68	46.03	−0.35	0.875	−7.96	16.53	43.75

Panel B.2: Domestic and cross border deals (towards Europe and North America, other countries not reported for very small number of obs)

	Domestic deals, 30 obs					Cross_Europe deals, 29 obs					Cross_NorthAmerica, 59 obs				
	CAAR (%)	P-value	Min (%)	Max (%)	% Pos (%)	CAAR (%)	P-value	Min (%)	Max (%)	% Pos (%)	CAAR (%)	P-value	Min (%)	Max (%)	% Pos (%)
(−1,1)	0.29	0.663	−5.15	4.30	53.33	0.46	0.374	−2.31	5.03	48.28	0.19	0.377	−4.70	5.93	49.15
(0,1)	0.13	0.954	−4.63	4.43	46.67	0.52	**0.076**	−2.28	3.93	72.41	0.00	0.917	−5.37	4.16	54.24
(−1,0)	0.38	0.405	−2.40	5.73	53.33	0.11	0.873	−3.18	4.66	58.62	0.20	0.261	−5.43	4.85	50.85
(−3,3)	0.52	0.328	−3.32	4.78	53.33	0.30	0.672	−4.73	6.52	55.17	0.47	0.284	−7.98	6.97	55.93

Panel B.2: Domestic and cross border deals (towards Europe and North America, other countries not reported for very small number of obs)

	Domestic deals, 30 obs					*Cross_Europe deals, 29 obs*					*Cross_NorthAmerica, 59 obs*				
	CAAR (%)	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*
(−5,5)	0.01	0.854	−5.07	6.21	43.33	−0.19	0.631	−7.09	7.23	48.28	0.58	0.348	−8.40	12.12	54.24
(−10,10)	−0.97	0.225	−12.61	6.66	40.00	−0.54	0.512	−10.82	10.84	44.83	1.08	0.140	−10.25	16.71	61.02
(−15,15)	−2.02	**0.054**	−13.11	11.88	33.33	−1.20	0.229	−13.69	10.05	34.48	0.61	0.570	−22.57	16.53	59.32

Panel C: Type of deals (categories are not mutually exclusive, so the sum is higher than the total sample size)

	INSURTECH P&C, 34 obs					*INSURTECH L&H, 11 obs*					*PRIVATE TECHNOLOGY, 109 obs*				
	CAAR (%)	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*
(−1,1)	0.42	0.225	−4.91	5.02	50.00	0.66	0.147	−1.89	3.55	45.45	0.23	0.383	−5.15	5.93	52.29
(0,1)	0.24	0.279	−1.87	3.99	67.65	−0.02	0.829	−1.87	1.45	54.55	0.02	0.634	−6.10	5.86	52.29
(−1,0)	0.47	0.166	−2.55	4.85	67.65	−0.06	0.825	−2.43	2.84	54.55	0.20	0.327	−5.43	5.73	50.46
(−3,3)	0.75	**0.047**	−7.49	5.48	61.76	0.95	0.178	−3.64	6.79	63.64	0.22	0.586	−7.98	6.97	49.54
(−5,5)	0.69	0.199	−8.48	6.36	55.88	0.26	0.659	−3.33	7.42	36.36	0.12	0.883	−8.40	12.12	48.62
(−10,10)	0.60	0.327	−13.69	6.66	55.88	−0.51	0.716	−10.25	10.14	54.55	−0.11	0.752	−13.69	16.71	49.54
(−15,15)	0.36	0.683	−12.92	9.09	52.94	0.58	0.900	−6.90	11.05	63.64	−0.82	0.120	−22.57	16.53	44.04

Panel D.1: Involvement in the deal as the lead investor

	Lead investor, 53 obs					*No Lead investor, 73 obs*				
	CAAR (%)	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*
(−1,1)	0.00	0.770	−5.15	5.03	52.83	0.33	0.155	−4.90	5.93	47.95
(0,1)	−0.19	0.337	−5.67	4.43	54.72	0.24	0.137	−4.64	4.16	56.16
(−1,0)	0.13	0.910	−5.43	5.73	49.06	0.23	0.237	−3.18	4.85	54.79

(continued)

Table 5.3 (continued)

Panel D.1: Involvement in the deal as the lead investor

	Lead investor, 53 obs					*No Lead investor, 73 obs*				
	CAAR (%)	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*
(−3,3)	−0.35	0.353	−7.98	6.52	41.51	0.71	**0.019**	−4.84	6.97	58.90
(−5,5)	−1.01	**0.053**	−8.48	7.23	39.62	0.76	**0.083**	−7.28	12.12	52.05
(−10,10)	−1.22	**0.070**	−12.61	8.76	37.74	0.72	0.245	−13.69	16.71	58.90
(−15,15)	−1.86	**0.017**	−13.11	11.88	37.74	0.06	0.962	−22.57	16.53	49.32

Panel D.2: Deal size (in quartiles, for 8 deals the information is not available)

	Q1, 29 obs					*Q2, 30 obs*					*Q3, 29 obs*					*Q4, 30 obs*				
	CAAR (%)	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*	*CAAR (%)*	*P-value*	*Min (%)*	*Max (%)*	*% Pos (%)*
(−1,1)	0.74	**0.057**	−2.88	5.02	62.07	0.02	0.887	−4.91	5.03	53.33	0.19	0.502	−2.57	4.91	41.38	−0.33	0.322	−5.15	5.93	43.33
(0,1)	0.49	0.146	−2.28	4.43	65.52	−0.20	0.587	−5.67	3.93	43.33	0.12	0.452	−2.33	2.79	51.72	−0.29	0.326	−5.37	2.76	56.67
(−1,0)	0.73	**0.028**	−2.55	5.73	68.97	0.05	0.929	−5.43	4.66	46.67	0.15	0.534	−2.06	3.16	48.28	−0.28	0.272	−2.64	4.27	43.33
(−3,3)	0.60	0.109	−3.64	5.44	55.17	0.01	0.779	−4.84	5.02	53.33	1.22	**0.022**	−3.83	6.79	55.17	−0.88	0.114	−7.98	6.97	43.33
(−5,5)	0.21	0.617	−7.09	5.72	51.72	−0.22	0.906	−7.78	6.21	50.00	0.88	0.392	−5.97	12.12	55.17	−0.89	0.176	−8.48	12.00	36.67
(−10,10)	0.82	0.419	−13.69	8.76	51.72	−1.05	0.299	−10.82	10.84	53.33	0.55	0.487	−12.61	10.14	55.17	−0.27	0.546	−9.98	16.71	43.33
(−15,15)	1.02	0.287	−12.92	11.88	68.97	−1.67	0.118	−13.69	10.05	36.67	−1.42	0.327	−22.57	11.05	37.93	−0.52	0.383	−10.29	16.53	40.00

This table reports the descriptive statistics of Cumulated Abnormal Returns estimated over various event windows for 126 InsurTech deals involving European (re)insurance companies from 2017Q1 to 2019Q4. Daily Abnormal Returns are obtained using the market model with a 250-day estimation period. The statistical significance of Cumulated Average Abnormal Returns is tested using the Boehmer et al. (1991) procedure to capture the event-induced increase in returns volatility with the adjustment suggested in Kolari and Pynnönen (2010) in order to account for possible cross-sectional correlation of abnormal returns. P-values are in bold when <0.10. *Source* Our elaboration on CB Insights, Crunchbase Pro, and Datstream data and investors with respect to M&As. This explanation is also supported by previous papers. On the one hand, Dranev et al. (2019) find a positive stock reaction to FinTech M&As in a cross-country sample over 2010–2018. On the other hand, Hornuf et al. (2020), analysing 140 FinTech alliances (both investments and contract-based agreements) involving 30 publicly listed banks over 2007–2017, find a value-reducing effect. While a weaker media attention might explain a negligible response in stock prices, it cannot justify a negative reaction. Following Hornuf et al. (2020, p. 17), "*a potential explanation for this is that in the future, banks might be reduced to innovation followers in the new financial ecosystem, with incumbent banks quickly losing their relevance*". Unfortunately, they only provide results for the overall sample and do not show any details for subsamples of transactions, based on some deal and target characteristics. The idea that incumbent operators could be progressively replaced by new entrants may also apply in the InsurTech environment. If we disentangle results for reinsurance and insurance companies, we find that—in the longest event window (−15; + 15)—the average CAR is 1.45% for the former and −1.35% for the latter, both statistically significant at least at the 10% confidence level. This may be an evidence that investments in InsurTech appear as more viable when the business of the investor is more difficult to imitate, which is the case of reinsurance companies that handle complex risks and operate on a global scale, generally without any direct relationship with the risk owners.

A concurrent explanation maybe that FinTech (and InsurTech) transactions, similar to IT investments in general, are perceived as high-risk investments, with uncertain effects on the company's performance. In this sense, Takeda et al. (2021) find that Japanese regional banks show a negative stock price reaction to the announcement of FinTech transactions when they assume the form of an investment, while no significant reactions are registered for business partnerships. This is consistent with the so-called IT profitability paradox, i.e. the absence of conclusive evidence with respect to the impact of investments in information technology on performance. On a theoretical basis, this may be due to the fact that technology can be considered as a commodity available to all market participants and hence not able to guarantee a lasting advantage over competitors. As outlined in some previous studies (e.g. Beccalli, 2007; Koetter & Noth, 2013), the banking industry is not an exception to the paradox. Beccalli (2007) finds that purchasing IT-related services improves profitability of European banks, while the acquisition of software or hardware has a negative effect on profits. Koetter and Noth (2013), analysing a sample of German banks, conclude that IT has a positive impact on bank output, but recognize that more research is needed to explain the nexus between bank productivity and specific profitability per output category. Finally, a recent paper by Kriebel and Debener (2020), measuring US banks' digital efforts through text mining, suggests that the IT profitability paradox should be related to organizational capabilities.

In order to better investigate the main drivers of market reaction, we consider several subsamples. First, we observe that investors' perception about InsurTech transactions has improved over time: while the only statistically significant CAARs are negative in 2017 and 2018, they turn positive in 2019. This may be due to a growing awareness of the potential positive impact of technological innovation and cooperation with InsurTech start-ups.

Looking at the geographical breakdown by country of origin, we can see from Table 5.3—Panel B that the strongest results are obtained by traditional (re)insurance companies located in France. We remain cautious in our interpretation because the findings could be driven by small sample size. Nevertheless, we can observe that the FinTech landscape is particularly lively in France (Gazel & Schwienbacher, 2020) with respect to other Eurozone countries (ECB, 2020a).

Considering the domestic or cross-border nature of the transaction, the empirical evidence in the existing literature is quite sparse, with both findings in favour of domestic transactions and cultural similarity and results in favour of cross-border deals and internationalization opportunities (e.g. Amici et al., 2013). In our sample, the most successful transactions are those in which the investor and the target are located in different countries, but are both in Europe (see Table 5.3, Panel B.2).

In Table 5.3—Panel C, we show results by type of the deal. Consistent with the IT profitability paradox, we find that the worst category is private investments in technology, while both P&C and L&H deals show better results. This finding should be interpreted with caution, since the number of private technology deals is much higher than for the other categories. However, it is in line with results by Takeda et al. (2021) and with the idea that technology is imitable and that the great value stands in the relationship with the customers, and then into alliances targeted to the offering of new product and services. The high risk and uncertainty perceived by investors is also reinforced by results obtained by distinguishing deals in which the traditional (re)insurance company is the leading investor or not. As we can see in Table 5.3—Panel D.1 the average market reaction is more positive when the transaction involves more investors and the (re)insurance company is not the one that contributes with the majority of funds. The presence of different investors is probably viewed as a signal of the quality of the invested start-up (for a detailed discussion of syndication as a value driver in private equity and venture capital, see Tykvová, 2018). Finally, looking at the breakdown for quartiles of deal size (Table 5.3—Panel D.2), we still find some evidence that a strong economic effort in this kind of transactions is not very much appreciated by investors. The largest operations (in the fourth quartile) show a negative reaction in all event windows, while the smallest ones have always positive significant CAARs, also statistically significant in the shortest intervals: (−1; 0) and (−1; + 1).

As a robustness check, we run our event study using also MSCI country indexes rather than the MSCI Europe (or using the EUROSTOXX index). Results are substantially confirmed and lead to the same conclusions.

5.4 Conclusions

There is no doubt that technological innovation is strongly impacting all phases of the insurance value chain, providing new opportunities and posing new risks. Even though the entry of new firms does not seem to pose an immediate threat to traditional companies, it is evident that a passive approach is not a viable strategy and that cooperation between incumbents and new entrants is gaining pace. According to McKinsey (2019), future business models will be marked by close partnerships where incumbents will focus their activity on customer relations development, while InsurTech—as innovators and bearers of new technologies and applications—will act on the value chain, providing technological support to this process of change. The outcome of this collaboration is a reorganization of the traditional insurance value chain, which will involve increased efficiency and flexibility, as well as the ability to respond quickly to market requirements (Deloitte, 2018).

Looking at the results of our empirical investigations, the announcement of incumbents' investments in InsurTech start-ups does not produce significant market reaction in the overall sample, with a high heterogeneity across time and location. A clear message seems to be that technology is imitable and that investors perceive more value in announced deals signaling cooperation aiming at the development of products and services.

Further research in needed to better understand what type of partnership create more value, also considering human and intellectual resources of both incumbents and target companies. Finally, there is no doubt that the COVID-19 pandemic will accelerate digitalization in the insurance sector and requires to expand the analysis and consider also the role of BigTech, which may be even more disruptive than the one of InsurTech start-ups.

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CHAPTER 6

FinTech and Banking: An Evolving Relationship

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6.1 Introduction

The FinTech phenomenon has disrupted the banking industry. The technological transformation of financial services is resulting in a change of paradigm (Arner et al., 2017; Stiglitz, 2017) that is involving the arrival of new competitors, the emergence of new business models and the provision of fully digital financial services. Most of the new suppliers are the so-called FinTech companies (OECD, 2018; Thakor, 2020). These start-ups companies have benefited from their digital capabilities to innovate in the provision of financial services. Due to the adoption, new technologies—e.g. blockchain, artificial intelligence, big data, or biometrics—, FinTech have started to offer new financial services—e.g. digital payments, peer-to-peer lending, robo-advisory, or financial planning.

Since their emergence, shortly after the 2007–2008 financial crisis, FinTechs have gained gradually ground as alternative financial providers. Fintech credit activity has expanded rapidly in many countries over recent years, albeit from a very low base (Cornelli et al., 2020). The rise of FinTechs has also made them gain an increasing investors' attraction since 2012. In this sense, the growth of raised funds by the FinTech firms reveals that the FinTech phenomenon has achieved a certain degree of maturity. Simultaneously, the surge of new digital financial services, which are offered by non-bank companies, has also increased customers' expectations. Consumers have seen that there is a new way of providing financial services, resulting in a progressive adoption of a number of FinTech services. Worldwide, 6 out of 10 people are actively using FinTech services (EY, 2019). Consequently, the arrival of these new financial services providers and the irruption of new technologies in the finance industry have challenged the role of banks as traditional financial intermediaries.

The incumbent financial institutions have gradually undergone through its own digitalization process (Carbó-Valverde et al., 2020a), but it seems that this technological transformation remains a key challenge for the global banking industry. Unlike prior technological waves that have affected the banking industry (e.g. internet banking), the FinTech wave has the potential to lower barriers of entry to the financial services market, to elevate the role of data as a key commodity, and to drive the emergence of new business models (BIS, 2018).

Despite being a disruptive factor, the relationship between these start-ups and banks has changed over time. Initially, FinTech firms aimed to disrupt the finance industry by replacing the traditional banks. This led to a pure competitive scenario. However, that perception has shifted over time. FinTech has realized that it is not easy to scale and grow in the finance industry. At the same time, they have understood that banks are large organizations which strong expertise providing financial services. Then, both, FinTechs and banks, have started to explore the possibilities to collaborate. Banks have realized that by establishing collaborations with FinTechs, they could benefit from the agile approach and technological background of these start-ups to transform more easily their digital capabilities.

This chapter aims to provide an overview of the competitive–collaborative relationship between FinTechs and banks. In doing so, we first examine in detail the FinTech ecosystem. This entails analysing the services offered by these new competitors as well as how the FinTech phenomenon has grown since its emergence. Secondly, we explore how do banks are facing the technological transformation of their industry. In particular, we examine the digitalization process of banks (quantitatively and qualitatively) and the risks and opportunities that this process entails for them. Thirdly, we explore how the relationships between the traditional banking sector and the fintech sector have evolved. Since the relationship has moved towards a more collaborative ecosystem, we pay attention to the types of alliances that could be established between both financial actors. Moreover, the benefits and risks of establishing these alliances are also underlined. Finally, we discuss the impact of COVID-19 on the FinTech sector and we provide an overview of the provision of digital financial services in the post-COVID-19 era.

6.2 FinTech: A Disruption in the Financial Sector

As the Financial Stability Board (2019) highlights, Fintech refers to the "*technology-enabled innovation in financial services with associated new business models, applications, processes of products, all of which have a material effect on the provision of financial services*". Similarly, The International Organization of Securities Commissions (2017) defines FinTech as "*a variety of innovative business models and emerging technologies that have the potential to transform the financial services industry*". Finally, the International Monetary Fund and the World Bank define FinTech as those *"advances in technology that have the potential to transform the provision of* *financial services, spurring the development of new business models, applications, processes, and products"* (International Monetary Fund & World Bank, 2018). All these definitions of the FinTech phenomenon agree on the disruptive power of a series of technological innovations with the potential to transform the finance industry. The use of new technologies in the provision of financial services could disrupt the industry because it allows reducing the financial intermediation costs in lending, payment systems, financial advising, and insurance, along with better products for consumers (OECD, 2020). Technology makes the development of products and services cheaper and improves the exchange of information, thus allowing easy access to a wider range of opportunities. Digital financial services are faster, more efficient, and typically cheaper than traditional financial services. Moreover, due to the rise in the level of digitalization of the societies, FinTech services could be accessed by the underbanked population.

Analysing the FinTech phenomenon globally, the term FinTech could be used with two main meanings. Fintech can be understood as the technological innovation that generates new applications, processes, products, or business models in the financial services industry. Moreover, this same term could be used to name all those companies, normally start-ups, which are effectively employing some technological innovations to offer financial products and services.

6.2.1 FinTech Services

Fintech activities can be observed in different types of financial services, such as deposits, lending, and capital raising, insurance, investment management, and payments, clearing, and settlement (Financial Stability Board, 2017). Those services could be mainly oriented towards final consumers (B2C FinTech) and/or towards companies (B2B FinTech).

6.2.1.1 Services Oriented Towards Consumers: B2C FinTech

- *Payments and Transactions*: national and international payments, micro-payments, instantaneous transfers, peer-to-peer payments, mobile phone payments, overseas remittances, and wallets.
- *Personal Finance*: Include online budgeting and financial planning tools for individuals.
- *Currencies*: Exchange services, such as securities, derivatives, fiat currencies, cryptoassets, or similar financial instruments.

- *Savings and Investments*: social trading networks, financial advice based on robo-advisors, trading platforms, and financial advice on real estate assets.
- *Lending*: Online credit, wage advances, peer-to-peer lending platforms, micro-credits, crowd-lending platforms, point-of-sale finance, online credit.

6.2.1.2 Services Oriented Towards Firms: B2B FinTech

- *Financial Infrastructure*: using and improving existing technology to provide financial services (e.g. cloud computing services, biometric identification, large data management, user authentication, and transaction/document signing, online payments processors, Mobile Point of Sale (mPOS) payment machines and readers).
- *Tax and accounting solutions*: online billing and invoice management tools, online cash flow, and liquidity management tools.
- *Consultancy solutions*: advisory services or business consultancy.
- *Lending*: online lending, peer-to-peer lending, factoring, marketplace financing.
- *Equity finance*: raising equity for projects and/or firms with an investment purpose. Crowd-equity platforms are included in this dimension.

6.2.2 The Global FinTech Phenomenon

The FinTech phenomenon, that emerged after the 2007–2008 global financial crisis, has evolved and expanded globally across developed and developing areas. Then, to understand how relevant is the FinTech phenomenon in global terms, we focus mainly on four dimensions: FinTech population, the total volume of FinTech credit, the total funds invested in FinTech activities and companies, and the adoption of FinTech services by consumers.

6.2.2.1 FinTech Population

According to Crunchbase,[1] there are around 30,416 FinTech firms actively operating (as of December 2020). Figure 6.1 shows the number of FinTech firms which are providing financial services in some selected

[1] https://www.crunchbase.com/.

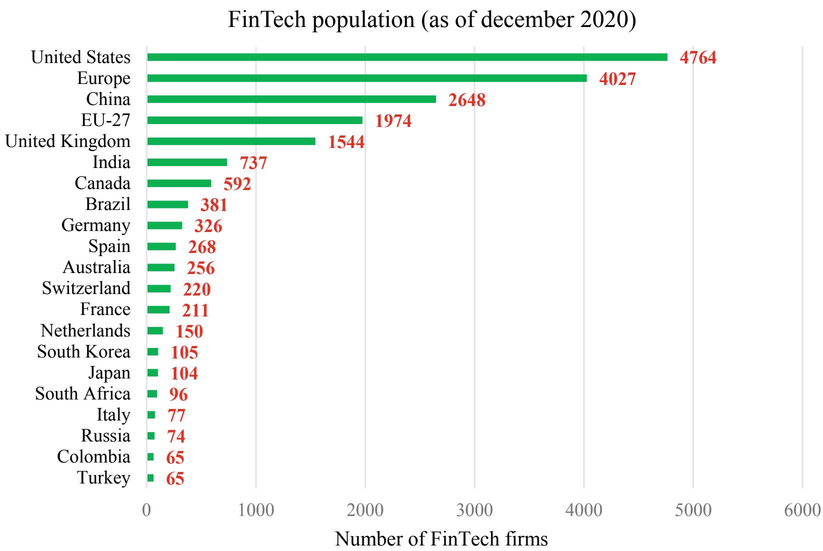

Fig. 6.1 FinTech population: number of FinTech firms (*Source* Crunchbase and own elaboration)

countries. This graph reveals that while FinTech firms are born all over the world, there are mainly for three FinTech geographical clusters: United States (accounting for 15,6% of the total FinTech firms), Europe (accounting for 13,2% of the total FinTech firms), and China (accounting for 8,7% of the total FinTech firms). To explain the drivers of FinTechs emergence, Haddad and Hornuf (2018) find that countries witness more FinTech start-up formations when the economy is well-developed and venture capital is readily available.

In this sense, the United States (U.S.) has the largest FinTech population, with 4764 FinTech firms. The U.S. FinTech sector is considered the largest in the world with many of those FinTechs based on some clusters areas such as Silicon Valley, San Francisco, or New York. In this sense, some of the more popular FinTech companies in terms of customers and valuation are based on these U.S. cities—Square, Ripple, RobinHood, Chime, Plaid. This geographical allocation in the United States is not random. In this sense, Gazel and Schwienbacher (2020), using data from France, find that most Fintechs are geographically clustered and that the location of new Fintech start-ups is affected, among other things, by the size of clusters and the presence of incubators.

Then, we can also observe that the European FinTech sector is also relevant, with 4027 FinTech firms. However, most of these European FinTechs are based in the United Kingdom (UK). UK FinTech firms represent around 38% of the European ecosystem. In this sense, the "City of London" plays an important role in attracting the creation of FinTechs.

Figure 6.1 also reveals that the emergence of FinTech firms does not merely occur in developed economies. The Chinese FinTech ecosystem is vibrant, with more than two thousand FinTech firms. While the FinTech phenomenon arrived later to China, the Chinese FinTech ecosystem is achieving scale and innovation rapidly. In the case of China, Hua and Huang (2020) identify three key drivers for China's fintech development: a shortage of supply in traditional financing, strong government support for promoting financial inclusion through digital technology, and a more tolerant regulatory environment. However, the evolution of the Chinese seems to be different, while U.S. and European Fintech firms have tried to succeed via specialization in a core field to expand geographically (e.g. the largest European neobanks are growing by expanding overseas), most of the Chinese Fintechs have typically focused on their domestic market by offering high-engagement consumer platforms. In this sense, the growth of some Chinese companies has made them become BigTech companies such it has occurred with Tencent and Ant Financial.

Moreover, also India and Brazil rank among the countries with more FinTech companies. In both cases, the emergence of this sort of companies is related to the provision of financial services to the unbanked or underbanked population. The large percentage of the unbanked population in those emergent countries is perceived as an opportunity for those FinTech born in those countries. Frost (2020) shows that unmet demand is a strong driver in emerging and developing economies and in underserved market segments.

6.2.2.2 FinTech Credit

While, as already mentioned in Sect. 2.1, FinTech activities can be observed in different types of financial services, the relevance of the FinTech sector could also be observed by the volume of credit provided by these FinTech companies. In this sense, a large volume of credit provided by FinTech companies would mean that those companies are playing a relevant role in the economy by financing consumers and businesses in the world. In this sense, Cornelli et al. (2020) find that FinTech lending is more developed in countries where banking sector mark-ups are higher and where banking regulation is less stringent.

During the period 2013–2019, the total volume of FinTech credit amounts to $1391,94 billion (Cornelli et al., 2020). Fintech credit activity has expanded rapidly in many countries over recent years, albeit from a very low base. In 2013, the global FinTech credit granted was about $9,94 billion. Then, six years later in 2019, the FinTech credit granted amounted to $223,30 billion. FinTech credit has become a relevant alternative source of financing in some countries. Figure 6.2 shows the FinTech credit per capita granted from 2013 to 2019 for some selected countries. The United States and China exhibit the largest ratio of FinTech credit per capita. On average a U.S (Chinese) consumer has received $761 ($745) during the period 2013–2019. This means that on average consumers of both countries have received annually more than a hundred dollars from FinTech companies. In global terms, this means that during this period the total credit granted by the FinTech sector accounts for $250 billion in the case of the United States and $1,037 billion in the case of China. Moreover, the FinTech credit is also relevant in the United

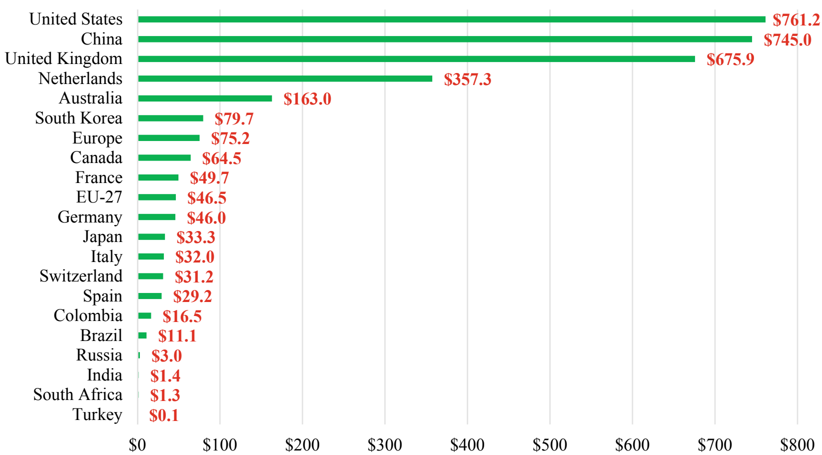

Fig. 6.2 FinTech credit per capita $ (2013–2019) (*Source* Cornelli et al. [2020] and own elaboration)

Kingdom, where the FinTech credit per capita exceeds $675. The rise of peer-to-peer lending platforms and online marketplaces in these countries would explain why FinTech credit is playing a larger role in these jurisdictions.

The relatively smaller volume of FinTech credit in some emergent economies such as India and Brazil, compared with their large number of FinTechs, reveals that in those economies, FinTechs are mostly offering mobile payments or digital money accounts.

6.2.2.3 FinTech Investments

The relevance of FinTech, and more significantly, its potential for growth could be observed by analysing the funds that the FinTech sector has been able to raise from worldwide investors. Investors' appetite for FinTechs would serve as an indicator of how markets assess FinTechs' capacity to transform the finance industry. Figure 6.3 shows the total funds raised by FinTech firms in some from 2010 to 2019. These figures consider the whole of external funds raised by FinTech (e.g. venture capital, seed capital, debt, equity crowdfunding, etc.). This graph reveals that FinTech has been gaining attraction from investors since 2012. The total volume of investments has increased annually since 2012, just except for 2017. In 2019, FinTech firms were able to raise $135,7 billion. The growth of raised funds by the FinTech firms reveals that the FinTech phenomenon has achieved a certain degree of maturity. Many investors have understood

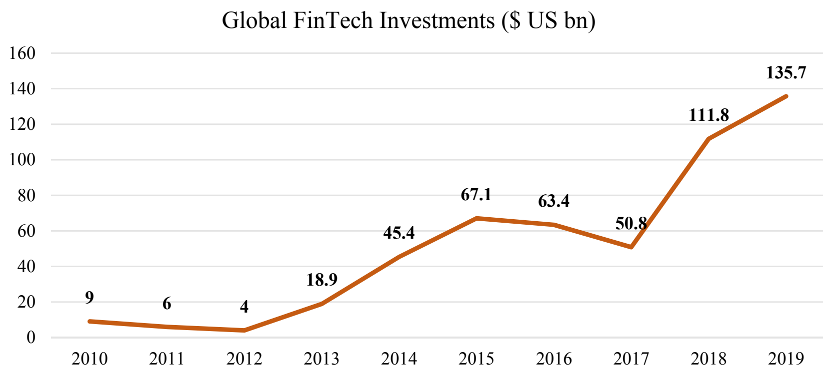

Fig. 6.3 Evolution of global FinTech investments ($US bn) (*Source* Statista and own elaboration)

that there are solid FinTech projects which could potentially transform the finance industry. Moreover, the rise in global FinTech investments also reflects that FinTechs firms have the potential to scale and grow.

6.2.2.4 FinTech Adoption

On the demand side, consumers also seem to adopt gradually FinTech services. The adoption of FinTech services has moved steadily upward during the last years across the world. On average, the FinTech Adoption index elaborated by E&Y reveals that the use of FinTech services has increased from 33%, in 2017, to 64%, in 2019. A consumer is considered a FinTech adopter, only if that individual has used two or more FinTech services during the last year. Then, worldwide, 6 out of 10 people are actively using FinTech services (EY, 2019). Figure 6.4 shows that the percentage of FinTech adopters for some selected countries. This figure reveals that, as above-mentioned, the adoption of FinTech services has increased between 2017 and 2019 in developed and developing countries. However, the largest adoption indexes are observed in emerging economies. Countries like China, India, and South Africa exhibit the largest adoption rates. In those countries, more than 80% of the population are using FinTech apps to conduct several financial activities. This finding suggests that FinTech is playing a key role in the financial inclusion of many people. As it has been underlined by the International Monetary Fund (Sahay et al., 2020) digital finance is increasing financial inclusion.

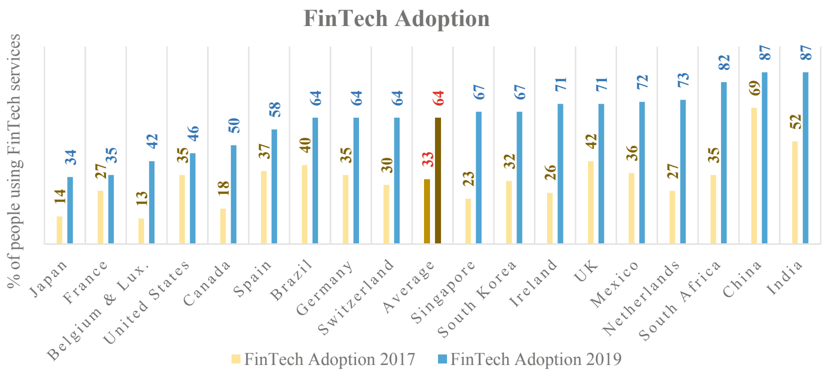

Fig. 6.4 Adoption of FinTech services in the world (*Source* EY and own elaboration)

In any case, high adoption index rates are also observed in developed economies such as Netherlands, United Kingdom, South Korea, or Ireland, which are above the average. In this sense, it is also relevant to observe that FinTech services are also gaining ground in many traditional bank-based societies, where banks are the primary financial intermediary to finance consumers and enterprises, to provide payment instruments, or to provide financial advisory.

6.3 The Banking Sector in the Face of the Emergence of FinTech

The provision of digitally enabled finance solutions is not exclusive to the FinTech sector. While the origin of the FinTech phenomenon could be partially explained by the relatively high cost of traditional channels in financial services (Philippon, 2018) and a relatively low level of trust in financial services incumbents (Cojoianu et al., 2020), banks have also reacted to the digital transformation of the finance industry. This digital transformation in the provision of financial services has become an opportunity, but also a challenge for banks. On the one hand, banks are currently adopting new technologies to transform their processes, products, and services to meet the digital needs of their customers. These technological innovations have helped banks to be more efficient and also to generate additional revenue. But at the same time, technology has also opened the door for new competitors (mainly FinTechs and BigTechs). Banks are facing the arrival of new competitors, which unlike them, are purely digital, by implementing a digital transformation of their business models to match today's pace of innovation and to keep them competitive.

6.3.1 Banks' Digitalization

The financial sector, and in particular the banking industry, have stood out for leading the technological transformation as well as in aggregate terms for having adopted new technologies faster. According to Computer Economics (2019), IT spending as a percentage of revenue in the financial services industry ranges between 4.4% at the 25th percentile to 11.4% at the 75th percentile. Across all industries, the finance industry is above the average in terms of IT expenses (Flexera, 2020), being substantially above other industries such as retail & e-commerce, healthcare, or manufacturing. In this sense, a financial entity at the 25th percentile spends more than a discrete manufacturer at the 75th percentile.

Focusing on the banking sector, from 2013 to 2017, banks' technological spending has grown by 19.7%, which represents an annual growth rate of 4.6%. Worldwide, the IT spending in the banking and securities sector will reach $523.9 bn in 2020 (Gartner, 2020). Moreover, this spending is also predicted to increase by 6.6% in 2021. To put this figure in perspective, that amount would represent 3% of the European Union's GDP or 2.5% of the U.S. GDP.

Banks' technological expenses are not just employed to improve or develop existing technologies, a significant share of banks' IT spending is used to implement new technologies. Table 6.1 shows that banks are increasing the technological expenditure which is specifically employed to adopt innovative technologies. In this sense, in 2020 U.S. banks are allocating 40% of their IT budget to new technologies, while European banks are allocating around 29%. Additionally, according to the predictions, it seems that the importance of new technologies on banks' IT budget will increase in the coming years. These figures suggest that banks have been also very proactive regarding the adoption of those technological innovations that will shape the future of finance (Table 6.1).

Table 6.1 % of banks' IT spending on new technology in North America and Europe from 2013 to 2022

	North America (%)	*Europe (%)*
2013	25	13
2014	26	15
2015	27	17
2016	28	19
2017	30	21
2018	33	24
2019	37	27
2020	40	29
2021f	44	31
2022f	48	33

Source Deloitte; Celent; Wall Street Journal and own elaboration

6.3.2 New Banking Technologies

Consumers aren't necessarily making their banking choices based on whether its main bank offers the latest new technology or not, consumers value an enhanced customer experience—simple, personalized, easy to access, and fast. However, to provide this type of experience, banks acknowledge that adopting the latest technologies is a must. Then, while banks are keen on adopting technological innovations in order to meet their customers' demands and to compete with the new players, there seems that the adoption of some technologies is being key for the banking industry. Due to the gradual implementation of these technologies in the banking industry, a new term has been coined: the *new banking technology*. Experts and insiders coincide in pointing out that seven technologies are believed to be the most disruptive in finance: big data, artificial intelligence, blockchain, cloud computing, mobile technology, biometrics, and the Internet of Things (IoT).

New technologies in the banking industry are being implemented by banks with several different applications. The adoption of these technologies allows banks to be more agile and efficient on their internal processes, to handle more efficiently information/data, or detect potential frauds. However, most of these new banking technologies are mainly oriented towards enhancing customers' experience. In this sense, it seems that banks are using these new banking technologies to improve their customers' experiences in an attempt to attract new customers and to retain the existing ones.

Moreover, banks are not implementing all these emerging technologies at the same pace. While cloud computing, mobile technology, and biometrics have been largely adopted in the banking industry, there are other technologies such as blockchain and the IoT, which are nowadays in an incipient phase of adoption. The complexity of developing a full blockchain network could explain why this technology, which is expected to revolutionize the finance industry, is not largely adopted. In this sense, it is important to highlight that some global projects have emerged within the banking industry to develop joint blockchain networks such as Interbank Information Network (IIN), We.trade, Marco Polo, and Komgo. Nowadays, IIN is the largest global blockchain-based network, with more than 200 member banks and with more than 300,000 daily transactions. IIN is a live blockchain platform aimed at facilitating overseas transactions using decentralized technology.

Finally, it is evident that banks are employing different strategies to implement these new technologies. In some cases, they prefer to purchase the technology due to their large costs of developing it internally, as it happens with cloud computing, artificial intelligence, and biometrics. In other cases, they establish partnerships with third-party providers, mainly with large technological companies, as is the case with blockchain and IoT. Finally, in the case of big data and mobile technology, they opt for developing them in-house.

6.3.3 The Digital Transformation of the Finance Industry: A SWOT Analysis

The digital transformation of the finance industry, as well as the arrival of FinTech competitors, depicts a challenging scenario for banks. Banks are ready to compete in this new competitive ecosystem due to their strong internal capabilities on the provision of financial services (strengths) but, at the same time, they also have some internal limitations (weaknesses) undermining their ability to face successfully a digital competition. While the FinTech phenomenon has been considered a disrupting factor in the banking industry (threats), banks may also benefit from the advantages (opportunities) that entail being competing in a more digital environment. Figure 6.6 provides a SWOT analysis of the banking sector regarding the digital transformation of the industry and the arrival of FinTech competitors.

Regarding banks' internal capabilities to face the challenging scenario, banks have some strengths and weaknesses. On one hand, banks are organizations with large expertise and a solid reputation providing financial services. Moreover, by providing several financial services, they hold strong relationships with their customers. In many cases, the same bank provides funding (e.g. personal loans or mortgages), payments instruments (e.g. credit and debit cards), financial advice (e.g. investments or pensions), and even insurance to their customers. Furthermore, while they are not pure digital organizations they already spend a significant fraction of their budget on technology. For example, banks were pioneers adopting online and mobile banking at the beginning of the 2000s. And more importantly, due to their larger size compared to FinTechs, banks have more resources ready to be invested in new technologies. On the other hand, while banks have tried to catch up with the latest technologies, they are not digital natives. FinTechs are born to be technological companies to provide financial services, while banks are traditional financial intermediaries aiming to digitalize themselves. Then, since they are not 100% digital companies, this implies that they tend to have larger difficulties to attract more digital customers. Moreover, unlike newcomers, they face larger regulatory costs, mainly because they take deposits. As heavily regulated companies, they face more difficulties to innovate. Additionally, banks have a strong organizational culture with rigid and solid structures that are not particularly agile to adopt innovations.

Despite the risks that entail the arrival of new technological competitors, banks may also benefit from the FinTech phenomenon. By adopting new technologies (e.g. artificial intelligence, big data, blockchain, etc.), banks could improve customers' experiences, which ultimately, improves customers' satisfaction. Moreover, banks could also use technological innovation to pursue a customer-centric approach based on improving the personalization of their products and services. In this sense, the deployment of big data and machine learning techniques may improve the knowledge about their customers. The technological transformation of their industry is also an opportunity to improve banks' efficiency. Some of these technologies are internally used to reduce costs (e.g. automatization of processes, implementing virtual assistants, etc.).

However, some threats may damage banks' competitive capabilities. The technological transformation of the industry and the emergence of new providers of financial services could make banks' customers, especially largely digitalized customers, to be more prone to switch to these newcomers. This may damage banks' market shares. Moreover, the entrance of FinTechs in the industry and their relatively good performance has also brought the attention of larger competitors. The arrival of BigTech companies, which are even larger and more profitable than banks, is likely to generate a large threat for banks. Moreover, being in a rapid changing ecosystem increases the risk of being made redundant if customers' needs are not met timely. Besides, the implementation of new technologies increases the risks of data breaches—digital companies are more vulnerable to cyberattacks—and could lead to technology biases—the use of artificial intelligence may generate biased decisions (e.g. biases on credit scoring due to sex, race, or religion beliefs).

6.3.4 *Scenarios of Future Banking*

The technological transformation of the finance industry and the arrival of new competitors increases the uncertainty about the future of banking. In this sense, the shape of the future banking industry will highly depend on the impact of these new competitors on banks' activities. Given the high level of uncertainty, the Bank for International Settlements has depicted a set of five scenarios, which are not mutually exclusive, towards which the banking industry may evolve.

- *Scenario 1—the better bank*: under this scenario the traditional banks go digital and to transform themselves becoming modern technological institutions. By doing so, banks can retain the customer relationship and their core banking services. In this scenario, banks adopt new banking technologies to enhance banks' products, services, and operations. Moreover, in the "better bank" scenario, banks have changed their business models to meet the digital demands of their fully digital customers.
- *Scenario 2—new banks*: this scenario implies that the traditional banks cannot survive the technological transformation of the sector and they are replaced by new fully-digital banks. Unlike traditional banks, these "new banks" do not have to adopt new technologies because they are born digital. Technology is in their genes. Under this scenario, the future belongs to those "new banks" which are able to provide more cost-effectively and innovatively banking services.
- *Scenario 3—distributed banks:* in this scenario the financial services become increasingly modularized. This implies a fragmentation of financial services into different niches. Traditional banks and new competitors (Fintech or large technological companies) coexist providing financial services. Under this scenario, traditional banks survive but they have to compete with other actors to own the customer relationship as well as to provide core banking services. Under this scenario, customers are able to have multiple financial service providers, each one provides different or complementary financial services.
- *Scenario 4—the relegated bank:* this scenario implies that the current banks become commoditized service providers and cede the customer relationship to other financial service providers—mainly

FinTech and BigTech companies. Under this scenario, these alternative financial service providers make use of front-end customers' platforms to offer consumers a variety of financial services from a diverse group of providers. Banks, which are able to survive thanks to their banking licenses, are relegated to provide core commoditized banking services through the front-end customers' platforms managed by FinTech and BigTech companies. However, the relegated banks may also retain the risk of the banking services that they provide.

- *Scenario 5—the disintermediated bank:* banks are no longer needed because the provision of financial services is disintermediated. This means that financial services are provided by agile platforms and technologies, which ensure a direct matching of final consumers depending on their financial needs (borrowing, making a payment, raising capital, etc.).

None of the scenarios could be potentially discarded. Moreover, as the Bank for International Settlements underlines some of the scenarios may coexist. In this sense, the lending segment may move to a "*disintermediated*" scenario—through the rise of peer-to-peer lending platforms—, the payment segment could move to a "*relegated*" scenario—with the surge of "super financial apps"—, and the provision of financial advisory services may evolve to a "*distributed*" scenario with the rise of automated investment advisory services by fintech firms through a bank or as part of a joint venture with a bank.

In any case, the impact and evolution of the technological transformation of the finance industry will depend on the response provided by the regulators. Especially, regulators have a say in the future of banking in three main areas:

1. <u>Regulation of financial service providers</u>: regulators may opt for moving towards the level-playing field which implies that new providers of financial services are regulated by the activities that they conduct not by the industry to which they belong. This means that new competitors would face the same regulation as banks if they conduct the same sort of financial activities. The fear of being heavily regulated, as it is the banking industry, could potentially deter some new competitors (FinTech and BigTech companies)

to enter the finance industry. In this sense, Jun and Yeo (2016) examine the entry of FinTech firms in the retail payments market to argue that there is a need for proper regulatory measures to reach a socially desirable outcome. Regulatory policies have the potential to shape competition. For example, Polasik et al. (2020) show that the adoption of PSD2 at the European level led to an increase in the number of newly established FinTech which operated in the payment industry.

2. Cybersecurity: a technological future requires to be prepared for a larger technological risk. The challenge of offering digital banking services at a high level of safety may shape who are the financial providers of the future. In this sense, only those companies that could ensure a high level of security could be able to provide banking services in the future.
3. Consumer protection: the evolution of the banking industry is also likely to depend on the ability of financial providers to ensure the protection of consumers' rights. It would be essential to ensure that the future financial providers have the ability to handle efficiently customers' data (avoiding potential data breaches) or to implement all the mechanisms to avoid discriminatory practices when employing technological innovations.

6.4 Banks and FinTechs: An Evolving Relationship

6.4.1 FinTech' License

Fintech companies can also be classified in terms of the license under which they operate. While in some jurisdictions, entities that engage in granting loans are not regulated under financial law and may only be subject to requirements under commercial law, most of the FinTechs need a license to provide financial services (Ehrentraud, Garcia Ocampo, et al., 2020). Accordingly, the following licenses exist: banking license, electronic money license, participatory financing platform license, and the payment institution license.

- The Banking License: It is granted to those Fintech companies that carry out the same activities as any other traditional bank, even though they may currently offer only some of the products available. There are some cases in which FinTechs have been granted a banking license, mostly it has happened in the case of neobanks and challenger banks. For example, N26 (a German neobank) and Revolut (a UK neobank) and have secured a banking license in 2016 and 2018, respectively, to operate in the whole European Union. In some jurisdictions, such as Singapore, Malaysia, Taiwan, Hong Kong, and South Korea, their competent authorities are granting specific digital banking licenses. Some of them have been gained by large FinTechs as Ant Financial. Obtaining a banking license (even if it is a digital banking license) allows digital banks to offer a full range of banking products and services to their customers. In this sense, digital banks are licensed to take deposits and use the deposited money to carry out their banking activities.

- The Electronic Money License (EDE): It is has been granted to those online platforms that issue electronic money, which is accepted as a means of payment by companies other than the issuing institution. These FinTechs with this type of license act as Electronic Money Institutions (EMIs). In Europe, there are 394 EMIs and most of them are relevant FinTechs in the European ecosystem as BNext (Spain), PayOne (Germany), Checkout (France), Monese (UK), or Flowe (Italy).
- The Participatory Financing Platform License (PFP): Fintech platform financing refers to those fintech activities that are facilitated by electronic platforms and provide a mechanism for intermediating funding over the internet (Ehrentraud, Garcia Ocampo, et al., 2020). This license enables the development of collaborative projects-financing mechanisms (crowdfunding). The requisites to obtain such type of license depend largely on each jurisdiction's regulatory body.
- The Payment Institution License (PI): It allows the institution to make payments or bank transfers, although its range of banking products is much smaller compared to traditional banking. This license, in turn, further contains a set of two sublicenses, which are the Payment Initiator License (PISP) and the Financial Aggregator License (AISP).
  - The Payment Initiator License (PISP) allows entities with online services the possibility to offer their customers to pay

immediately for their online reservations or purchases on the Internet.

- On the other hand, the Financial Aggregator License (AISP) is a tool that concentrates all the banking products contracted by a person or an entity in just one platform or application, thereby gaining greater control over the distribution of their money.

6.4.2 *Competition, Collaboration, and Coopetition*

The relationship between FinTechs and banks has moved from a pure competitive scenario to a more collaborative one. Relationships between the traditional banking sector and the FinTech sector have evolved significantly over the last several years.

When the FinTech phenomenon took off in the wake of the crisis, the relationship between these newcomers and the banking sector was viewed through the prism of direct competition. The first generation of FinTech companies aimed to disrupt the finance industry by replacing the traditional banks. At the same time, banks perceived them as a threat to their market shares. Banks viewed Fintechs as disruptors capable of disintermediating the core financial services, which consequently, would lead them to lose their customer relationships in favour of these technological innovators. However, that perception has shifted over time as banks and Fintech firms have explored the possibilities of collaboration. Banks realized that by establishing collaboration with FinTechs they could benefit from the agile approach and technological background of these start-ups to transform more easily their digital capabilities. At the same time, FinTech realized that replacing banks was not an easy task even if they had a technological competitive advantage. Moreover, FinTech understood that to survive, grow, and have access to a large base of customers some form of partnerships with banks were important. Through an alliance, an incumbent bank and a fintech start-up may achieve a midway approach that harnesses each other's expertise to achieve a competitive advantage in the financial ecosystem transforming around new technology (Svensson et al., 2019). Carbó-Valverde et al. (2020c) show that the adoption of non-bank payment instruments happens when consumers are already diversified digital banking customers. Their findings suggest a certain degree of complementarity between banking and non-banking digital services that could be exploited with strategic partnerships. In a similar vein, Cornelli et al. (2020) examine the growth of FinTech credit to conclude that these alternative credit seems to complement other forms of credit, rather than substitute for them.

Additionally, as Cygler et al. (2018) underline, one of the generic motivations of strategic alliances between banks and FinTech surge from the need to compete with a stronger common competitor. In this case, the arrival of BigTechs firms in the finance industry has also made banks and FinTech to collaborate in order to offer better digital solutions to face the threat posed by these large technological companies.

In this sense, Hornuf et al. (2020) conducted a research that examines the alliances between FinTech and Banks. In doing so, they examine the 100 largest banks in Canada, France, Germany, and the United Kingdom with the aim of discovering the different forms of alliances with FinTechs. They document a perceptible increase in bank–FinTech alliances in all these countries from the year 2013 onwards. During the period from 2007 to 2017, around 39% of all banks covered in their study engaged in some form of alliance with a FinTech. Carbó-Valverde et al. (2020b) also show, in the case of Spain, that FinTech and bank ties were particularly strong since 2018. Recently, there have been a number of successful partnerships between banks and FinTechs: Bank of Montreal and Blend (2019—to deliver digital mortgages and home equity experiences to customers), Bank of America and Zelle (2017—allowing customers to send, receive, and request money via mobile), TD Bank and Flybits (2015—to provide customers with more personalized mobile banking experience), Unicaja and Ebury (2019—to provide customers currency exchanges).

Nevertheless, the establishment of strategic partnerships between both actors does not hide that banks and FinTech have the same objective, to gain market share in the provision of financial services. For some financial services, banks and FinTechs have realized that is better to collaborate, providing jointly some financial services, intending to obtain mutual benefits. However, there are some other segments of activity where it is more difficult to enjoy synergies, so they have opted for competing. This double-side relationship, where banks and FinTech compete and collaborate simultaneously in different segments of activity, has been coined as "coopetition". For example, nowadays many banks are collaborating with FinTech companies to develop joint solutions to offer new mobile onboarding services, enabling customers to open an account with just a photo ID and a selfie. Simultaneously, there is fierce competition in the lending markets in order to finance consumers' financial needs. Figure 6.5

	BigData	Artificial Intelligence	Blockchain	Cloud Computing	Mobile Technology	Biometrics	Internet of Things (IoT)
Definition	Technology that allows handling large amount of information/data within an organization for business purposes	Technology that enables the use of cognitive techniques, such as natural language processors and advanced algorithms to analyze texts and identify feelings and other information from unstructured data	Technology that structures data and information in a chain of blocks with the aim of creating a single, consensual and distributed registry network with several nodes	Technology that allows the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence—over a public or private net	Technology used for cellular communication and other related aspects	Technology that analyzes physical or behavioral human characteristics in order to digitally identify a person to grant access to systems, devices or data	Technology that interconnects via internet of a number of computing devices which are embedded in everyday objects, enabling them to send and receive data.
Main uses in banking	o Enhance consumer experience	o Personal assistant and augmented reality	o Cross border payments	o Data management	o Enhance consumer experience	o Enhance consumer experience	o Enhance consumer experience
	o Credit scoring	o Automated decision-making	o Regulatory compliance	o Enhance consumer experience	o Offer new services	o Authentication and digital identity	o Customization of products and services
	o Customers' segmentation	o Regulatory compliance	o Smart contracts	o Improve efficiency/Cost saving		o Customers' segmentation	o Transaction automatization
	o Risk management and fraud detection	o Enhance consumer experience	o Back-office processing	o Business agility			o Back-office processing
Adoption in the banking sector	Medium-high	Medium	Incipient	High	High	High	Incipient
Implementation	Developing in-house	Purchasing the technology	Partnering	Purchasing the technology	Developing in-house	Purchasing the technology	Partnering
Fuente: EY Global Banking Outlook y elaboración propia							

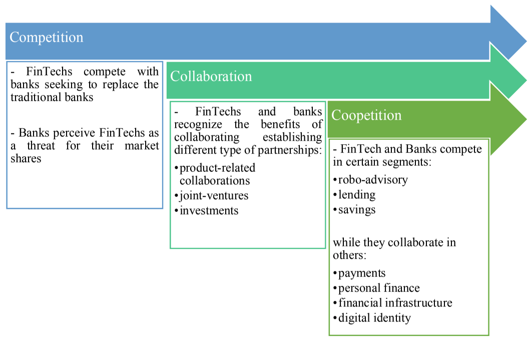

Fig. 6.5 Relationship between FinTechs and banks: Evolving landscape

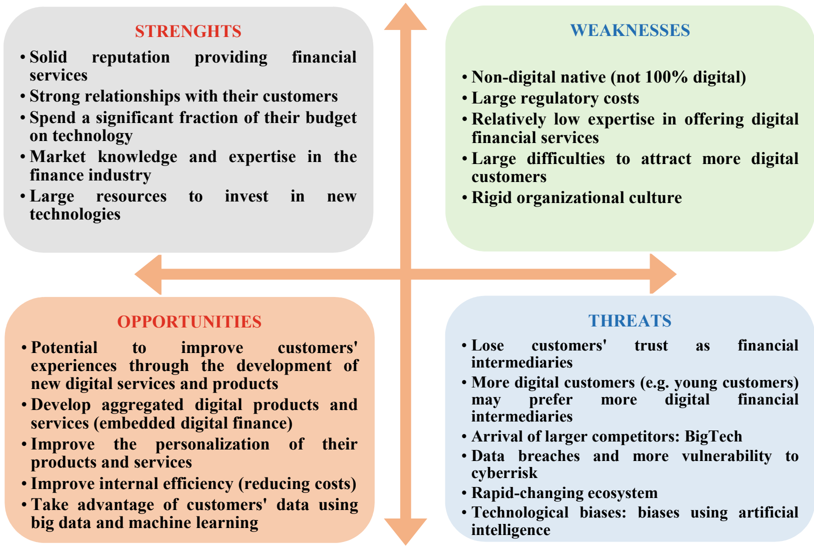

Fig. 6.6 SWOT analysis for the arrival of FinTech competitors to the banking industry

summarizes the use of the new technologies in the banking industry and provides an overview of the different settings of banks and FinTech relationships.

6.4.3 *Bank and FinTechs Alliances*

Banks and FinTechs have established collaborations since they have both understood that there are mutual benefits. Their different approaches to their businesses could generate synergies for both players. Specifically, for banks, working together with FinTechs allows them to improve their technological capabilities and reduce costs. It could be more costly for banks to develop their internal solutions than working closely with FinTechs that, unlike them, have the technology in its DNA. Moreover, through strategic partnerships, banks would be able to offer new and better technological solutions to their customers. This would allow banks to enhance customers' experience of their customers (e.g. adding functions and features, improving the ease of use, offering safer solutions, etc.), and also they could serve new customers' segments. Particularly, those consumers looking for better digital solutions to manage their finances could be more prone to switch banks.

Simultaneously, FinTechs also may benefit from collaborating with banks. For these start-ups, a partnership would allow them to broaden their consumer base and scale. In their early stages, many FinTechs are struggling to reach customers, a partnership allows them to offer their innovations to large bases of consumers. This also allows FinTechs to build up a reputation. Finally, as already mentioned, collaborations between banks and Fintech allow them to join forces to face common competitors such as BigTech companies (Fig. 6.6).

However, while both players may obtain mutual benefits by working together, there are also some risks that they have to assess when deciding to go for a partnership. Even if they both could reach a high level of complementary there are some cultural shocks. While FinTechs thrive on being fast-growing, agile, and innovative with new technology, major banks tend to have more solid and rigid structures. These cultural shocks and misunderstandings may generate difficulties in sharing information. Moreover, since FinTechs are having access to banks' customers, banks may face the risk of losing customers' relationships. Eventually, some customers may perceive that the FinTech is able to perform the same services without being a bank customer, so they could be more keen on leaving the bank to be FinTechs' customers. Additionally, the safety controls implemented by FinTechs (in terms of reducing the risks of cyberattacks, protecting customers' financial information, etc.) do not seem to be as solid as those implemented by banks (which are the organizations that spend the largest amounts on security). In this sense, FinTechs' vulnerabilities may also damage banks, especially if FinTechs have direct access to customers' data.

But not only do banks take on some risks when they collaborate with a FinTech, but the latter can also be harmed. By sharing technological innovation with a bank, the FinTech may lose some control of the innovation. Moreover, having access to banks' customers means facing larger regulatory costs. Banks are heavily regulated and third-party providers also face regulatory costs when they are providing financial services to banks' customers. Table 6.2 summarizes all the benefits and risks for both actors in establishing a partnership.

There are several ways by which banks and FinTechs are able to interact and to establish alliances/partnerships:

Table 6.2 Banks and FinTechs: Benefits and risks of establishing a partnership

	Banks	*FinTechs*
Benefits	• Offering more functions and features to consumers • Reduce costs • Improve technological capabilities • Opportunity to serve new segments of customers • Access to top talent and cutting-edge technology • Join forces to face the arrival of BigTech companies	• Building up brand reputation • Increase ease-of-use • Broaden consumer base • Ability to scale quickly • Join forces to face the arrival of BigTech companies
Risks	• Face a cultural shock • Share customers that could potentially switch • Face difficulties with information sharing • Lose customers' relationship • Face safety issues	• Face a cultural shock • Lose the control of the innovation • Face regulatory and compliance costs • Share key/secret aspects of the technological innovation

- Collaborations through innovation facilitators: As the FinTech ecosystem grows around the world, many jurisdictions are setting up innovation facilitators to foster the digital transformation of the finance industry. As a report from the Financial Stability Institute (FSI) of the Bank for International Settlements establishes (Ehrentraud, Garzoni, et al., 2020), there are three main types of facilitators: innovation hubs, regulatory sandboxes, and accelerators. While there are differences among them,[2] these innovation facilitators allow banks and early-stage FinTech to work together on a common project. Moreover, by interacting under the supervision of the regulators both players receive support, advice, or guidance in navigating the regulatory framework or identifying supervisory policy or legal issues and concerns. Typically, this type of collaboration is established at the early stage of the FinTech. In some cases, banks also develop their private accelerators in order to track since the very first moment those most promising start-ups.
- Product-related partnerships: Banks and FinTechs may decide to collaborate together to develop jointly a product or service. This kind of partnership, which is strictly a single-project alliance, could be mainly developed in three ways:

    1. *Internalization*: The FinTech company integrates directly with the internal bank system in order to provide a product or service for the bank customers. In this case, the bank and the FinTech partner bear responsibility and control over the customer experience.
    2. *Outsourcing*: The bank outsources the overall product to the Fintech company. By doing so, the bank relies on FinTech, which acts as a third-party service provider, for operational support of technology-based financial services. While operations can be outsourced, the risks and liabilities associated with those operations remain with the banks.
    3. *Separate joint venture business*: the bank and the FinTech set up a separate joint venture business, possibly a new company. By doing so, both offer a new product or service which is not

[2] See Ehrentraud, Garzoni, et al., (2020) for a distinction of the characteristics of innovation hubs, regulatory sandboxes and accelerators.

offered with the brand of the bank nor the FinTech, it is offered by a new company that is owned by both entities.

- Equity investments: This implies that the bank invests actively in the FinTech firm. This means that the bank acquires some stocks from the FinTech, becoming owning part of the FinTech. Some banks decide to invest in FinTech in order to ensure the stability of prior partnerships. These equity investments should be differentiated from acquisitions. Typically, an equity investment represents a minority stake in a FinTech (the bank owns less than 50% of the FinTech's capital). Through an investment, banks are able to internalize the knowledge of the FinTech better and gain control over the company by having a seat on the board of directors. This allows the bank to align FinTech and bank's interests. For FinTechs, these kinds of investments allow them to raise capital, which is essential for them to scale and grow. There are several types of investments depending mainly on the stage at which they are done: seed capital, early venture capital, series A capital, series B capital, series C capital, late venture capital, and growth equity. Hommel and Bican (2020) argue that banks have shifted from traditional money-lending activities (i.e. debt-financing) to becoming stakeholders in FinTechs, and hence, equity investors.
- Merger and acquisition (M&A): It is not an alliance "per se" because it means that the bank has acquired a majority stake in a Fintech. Then, the bank becomes the main owner of the FinTech. This means that the acquiring bank runs the FinTech. Over the last years, there have been large deals. Morgan Stanley bought E-Trade for $13bn (2020), ING bought PayVision for $360 mn (2018), JPMorgan bought WePay for $220 mn (2017), Santander acquired a majority stake in Ebury for €453 mn (2019). However, as FinTechs are gaining scale they have also started to buy some banks. LendingClub, a San Francisco-based peer-to-peer (P2P) lending firm became the first fintech to buy a U.S.-regulated bank following the $185 million acquisition of Radius Bank in February 2020.

6.5 FinTech and Banks: The Provision of Financial Services in the Post COVID-19 Era

COVID-19 has profoundly impacted financial systems across the world, including the provision of digital financial services and the functioning of FinTech markets (CCAF; World Bank; World Economic Forum, 2020). On one hand, the global pandemic has had a negative impact on the FinTech sector, as the sharp decline in the total FinTech investments during the first half of 2020 reveals. During the toughest times of the pandemic FinTech firms have experienced large difficulties to attract investors' attention which undermines their capabilities to scale and grow. Moreover, the coronavirus outbreak has also caused an increase in the percentage of loan impairments within the FinTech sector. Despite these negative effects, COVID-19 has presented an unexpected opportunity to make further use of digital channels. There has been a major shift in customer behaviours. The sharp rise in the use of banks and FinTechs apps shows that people, especially those who have the lowest levels of digitalization, have rapidly increased the use of digital channels to conduct several financial activities. Moreover, FinTechs, but primarily, banks have also reacted to the crisis by being increasing the speed at which they are transforming themselves. While the arrival of the vaccine forecasts that the more difficult times are over, the acceleration in the digital transformation of societies and organizations seems to continue.

6.5.1 The Impact of COVID-19

The coronavirus outbreak has had a strong negative impact on FinTech financing. Global Fintech funding dropped significantly since the outbreak of the pandemic. According to KPMG (2020), global FinTech investments reached $25.6 billion in the first half of 2020, which is a 32.45% decrease compared with the first half of 2019. Fintech deals dropped during the toughest times of the pandemic as investor appetite for fintech financings slowed, mainly due to the broader market uncertainty. Deals are fell across all geographies, indicating that COVID-19's impact on FinTech was global (CB Insights, 2020). During the second half of 2020, the level of investment in the FinTech sector has been progressively recovering, although without yet reaching pre-pandemic levels. The decline in global FinTech investments has relevant implications for the industry. In this sense, the lack of funding as a result of the pandemic is putting more pressure on FinTech companies to obtain profits sooner to scale, grow, and survive.

Despite the global drop in FinTech investments, the impact has not been homogeneous across FinTech activities. FinTech lending companies and platforms are the ones that have experienced the biggest drop in their level of financing. In Europe, during the first half of 2020, these online FinTech lenders raised 38% less through venture capital compared to the first half of 2019 (PitchBook, 2020). The fear that the deterioration in economic activity will increase the volume of unpaid loans could explain why many investors were reluctant to finance these FinTech companies. By contrast, the payments sector is on track to beat last year's record investment. The boom in digital payments due to the health crisis has meant that FinTechs that offer new forms of payment—contactless, QR, voice payments, or ultrasonic payments—captured the appetite of a large number of investors.

Moreover, the COVID-19 crisis has also increased the loan default rates in the FinTech lending sector. The slowdown in economic activity caused difficulties to a significant number of FinTech borrowers, in many cases individuals and small companies that had not obtained bank financing due to their risk profile, to have repaid their FinTech loans. The Global COVID-19 FinTech Market Rapid Assessment Study led by the World Bank (CCAF; World Bank; World Economic Forum, 2020) report a 14% increase in arrears or late repayments and a 9% rise in the number of defaults on outstanding loans relative to Q1 and Q2 2019. In the United States, one of the countries with the highest level of FinTech credit per inhabitant, the growth of FinTech loan defaults increased significantly during April 2020. The total percentage of FinTech loans with payment impairments reached 16%, while before the coronavirus crisis that percentage was around 6% (Dv01 Insights, 2020). This increase was even greater in some segments of borrowers. Thus, in those FinTech loans granted to debtors who had a higher risk profile, the percentage of defaults reached 20%.

Furthermore, the financial position of FinTechs has deteriorated during COVID-19. According to CCAF; World Bank; World Economic Forum (2020), more than half of FinTechs reported that COVID-19 negatively impacted their capital reserves, with 21% of firms reporting a significant impact and 30% reporting a slight impact.

6.5.2 Digital Finance in the Post-COVID-19 Era

In just a few months, we've seen the kind of consumer behavioural shifts that usually take decades. Consumers have started to adopt the digital channel to conduct their financial activities—check current account balances, open a bank account, apply for a loan, transfer money, make regular payments, etc.,—and to interact with their provider of financial services. The acceleration of the digital transformation of societies, and particularly, in what regards to the management of personal finances, depicts a new scenario for the provision of financial services in the post-COVID-19 era that is likely to be characterized by:

- Further use of digital channels (rise of banks and FinTech apps): Financially speaking, consumers have gone digital. Banking and FinTech apps have grown significantly in use since the pandemic. Some of the most popular applications in the *apps stores* were banking apps. Similarly, in Europe, the use of FinTech apps increased by 72%. As societies are increasingly digital, the sudden boom in the adoption of these apps as a result of the COVID-19 pandemic may anticipate a social change towards societies used to manage their personal finances through the online channel.
- Adoption of new digital payments: The usage and adoption of digital payment methods have increased dramatically since the outbreak of COVID-19. It is estimated that contactless payment methods have grown by 40% globally since the beginning of the epidemic. According to Capgemini (2020), more than a third of consumers discovered a new payment provider during the COVID-19 crisis. Their research finds that 64% of consumers say they use contactless payments often and 48% use digital wallets, including QR code-based payments. Customers are more willing to adopt non-cash payment methods: contactless cards, smartphone payments, QR codes, wearables (e.g. bracelets, watches), voice payments, or payments methods with augmented reality devices. Consumers welcome different alternatives. They consider that this possibility of choice is beneficial.
- The emergence of new relationships: The confinement and social distancing measures that emerged as a result of the COVID-19 health crisis have altered how banks and other banking service providers interact with their customers. To transmit and gain the

trust of consumers in a post-COVID-19 environment, where the digital channel prevails, it is key that the client and entity maintain contact but in a more intelligent way. This type of "intelligent relationship" that must permeate all business areas is, however, key in those where human relations have traditionally prevailed, such as wealth management. Artificial intelligence makes it possible to improve the user experience, the user interface, usability, and, of course, data management. Smart systems can learn about customers and then can integrate more data sources and translate that data into actionable insights to make customer–bank interaction more successful.

- Transformation of banking channels: The implementation of measures to ensure social distancing has increased the use of alternative online channels such as video banking. This channel provides the opportunity to carry out banking transactions or professional banking inquiries through a remote video connection. This connection can be made through smart ATMs, in bank branches enabled for videoconferencing, or from a mobile phone using the bank's app. Thus, although its use was already on the rise before the coronavirus health crisis, some studies confirm that video banking has gained since the pandemic and it is estimated that it will continue to grow in the new post-COVID-19 reality. During the health crisis, this new technology has proven its usefulness especially in China where the technology has spread to more than 30 financial institutions and is in use in large and small branches. One of the main providers of video-banking solutions, POPi/o, points out that communications between customers and banks via video tripled since the coronavirus pandemic began.
- Improving financial inclusion: During the COVID-19 pandemic, technology has created new opportunities for digital financial services to accelerate and enhance financial inclusion. Digital finance is increasing financial inclusion and is associated with higher GDP growth (Sahay et al., 2020). The large penetration of the smartphone across the world—in 2020, the number of smartphone users in the world today is 3.5 billion, which translates to 44.69% of the world's population owning a smartphone—allow people who were underbanked to have access to digital financial services.
- New financial products: The COVID-19 pandemic has created new financial needs for digital consumers. Banks and FinTech have started

to innovate creating new financial products to meet their customers' needs. Banks will offer digital mortgages, crypto saving accounts, or digital currency exchanges. According to CCAF; World Bank; World Economic Forum (2020), 60% of surveyed FinTech firms reported launching a new product or service in response to COVID-19, with a further 32% planning to do so. Especially, in the segment of digital payments and digital lending.

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CHAPTER 7

FinTech Cultures and Organizational Changes in Financial Services Providers

Timothy King and Daniele Angelo Previati

7.1 Introduction

Financial services have played a fundamental role throughout much of human history, as a platform for delivering economic growth and development. They provide benefits to both private citizens and businesses that can help with addressing uncertainty, building credit and saving, while similarly channeling funds to where they are most productive using different techniques and technologies (Arner et al., 2016; Alt et al., 2018; Mauss, 2006; Thakor, 2020).

The management of data and information is increasingly vital in the provision financial services, and every time there is technological change or "disruption" (incremental or radical), then providers and consumers

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must adapt to these changes. However, technology is not an independent or completely exogenous force. Instead, it is developed by individuals and organizations—often in collaboration and with innovations built on new technologies—and then applied and diffused across sectors by both individuals, firms and other players. In the contemporary financial services environment, we use the word FinTech, to describe the transformative effect of technological-led innovations on the financial sector. A popular definition of the term FinTech, which we adopt in this chapter, is provided by the Financial Stability Board (FSB, 2019, p. 1) who define Fintech as "*technology-enabled innovation in financial services with associated new business models, applications, processes of products, all of which have a material effect on the provision of financial services*". This is a useful definition because it highlights the fact that technological innovation is disrupting the existing financial services landscape and also since the FSB is a very important international institution that shapes the evolution of the global financial system through regulatory recommendations, which are implemented by major economies across the world.

From this definition, we can understand that the concept of FinTech is very broad, and any analysis of the impact of technology, or of other socio-economic variables, must be discussed from an open, holistic and interdisciplinary perspective. This is also the view of information systems (IS) researchers: "*Studying the issues associated with the Fintech Revolution in future years will be more effective when IS researchers employ interdisciplinary research designs, theory and thinking, and methodologies*" (Gomber et al., 2018, p. 258). We argue in this chapter that the same approach is useful in the field of social sciences, where banking and finance, management and economics reside.

To answer the question of how new technologies are influencing and will influence Financial Services Providers (FSP), it is necessary to first distinguish among them. From a terminological point of view, it is interesting that we refer to some of these providers as incumbents (consistent with an industrial organization view). Incumbents are existing and well-established Financial Institutions (FI), including banks (depository institutions, retail and commercial) and non-banks (specializing in areas such as corporate lending and finance, asset and wealth management, consumer lending and insurance). The New Entrants (NE) in the financial services industry (FinTechs and BigTechs) are not normally called financial institutions, although notably a number of them (especially some FinTechs) are regulated and under the supervision of banking, insurance and financial markets authorities. Some of these have, in recent times, obtained payment licenses, which means they adhere to strict banking sector regulation and can call themselves "banks", yet they are not banks in the real and traditional sense.

An important point to consider is that the Corporate Cultures of FI and NE are quite different, attributable to their very different origins and business histories. However, in the future cultures will likely become blurred to some extent as human capital moves between NEs and FIs. Although the increasing integration of FIs and financial markets and blurring between them have been widely commented on, much less discussion has so far been given to the blurring of boundaries between FI and NE. However, the blurring of boundaries between FIs and NEs will increase in the future, which will further serve to shape the financial services industry. We now have a significant and growing literature on the emergence of FinTech since the Great Financial Crisis (2008). Much of this literature coincides with the rapid acceleration in FinTech development and proliferation over the last five years. Moreover, this research comes from diverse sources including researchers from different fields (economics, general management, marketing, organization studies, banking and finance, IS), as well as public authorities, supervisory authorities, and consulting firms with different focuses (strategy, Information and Communications Technology (ICT), operations). Nevertheless, despite this growing body of work, it is very difficult to find a critical overview of emerging Fintech cultures and the organizational changes being driven directly or indirectly by FinTech innovation. Instead different fields have focused on individual aspects. For instance, changes to organizational structures in the financial services industry and in specific FSP are rarely the objects of management studies or of banking and finance studies. Furthermore, although in the discipline of management studies, there now exists a limited body of research on this subject; however, with some exceptions, it does not go very deep in to financial services industry firm profiles—especially from an organization design point of view. Similarly, in banking and finance studies, a research style "from the outside" dominates, which is based on the use of public datasets, and real functioning (operational processes, organizational structure, people end culture management, leadership styles) have largely been left to the anecdotal or advisory literature. In most of the scientific literature (except sociology or psychology research fields), FSP are essentially black boxes. To these authors, it is therefore surprising, and it seems a contradiction, to, on one side, assert that banking (and the financial services industry as a whole) is characterized by being opaque and complex, while on the other side, largely leave the task of analyzing "from within" the black box to advisory firms, external auditors and regulatory bodies; while social scientists (economists, management scholars and banking and finance researchers) generally underestimate the importance of decision-making processes and organizational choices within the black box of FSP. To study FinTech innovation without analyzing its relationships with corporate culture and organizational changes is erroneous; we cannot fully contribute to understanding as to how firms are shaped by dynamic real-world environments, as well as the opportunity to offer frameworks that can help other researchers, managers, board members, regulatory bodies and supervisory authorities to make better decisions about FinTech developments including probable impacts on societies and economies.

The main aim of this chapter is to establish a useful research framework, that can help the reader understand about emerging FinTech cultures and organizational changes in FSP, while account for and shining light on other key differentiators (including business lines and business models, size, geographic presence, and governance structures) that influence the innovation process. Of course, since this chapter represents one of the first pieces of scholarly work to do so, another important aim is to also identify some key issues and research questions that merit deeper analysis.

With these objectives in mind, the rest of the chapter is structured according to the following three sections:

1. A presentation and discussion of an institutional approach, useful for describing current and future situations of FSP coping with FinTech innovation;
2. A presentation of the main challenges faced by cultures and organizational profiles of FSP in front of technological innovation, following the open innovation approach;
3. The identification of selected actual and future issues in managing FinTech cultures and organizational changes—specifying future research streams concerning these issues.

7.2 Rules and Cultures as Mechanisms Influencing FSP Innovative Behaviour

Technology-enabled innovation in FSP is not only a matter of choices about ICT and API, or some other digital technology application; instead, it also encompasses other strategic and organizational profiles (business models, production and delivery processes, human capital effectiveness, and so on). In addition, it also refers to culture, which is a social construct widely used in management literature, and cited in the real world of business as a fundamental factor influencing human behaviour. Also, with respect to FinTech, we can find a number of definitions that attempt to incorporate culture, yet many may appear quite contrived. An exemplar is Aloulou (2021, p. 74), who considers "*FinTech culture as a vibrant digital, agile, customer-centric, creative technology-driven, and entrepreneurial culture in a digitalized and changing world*". It is the opinion of this author that there is a pressing need to go deeper in order to analyse FinTech cultures in an effective and meaningful way.

Cultures and rules are core factors of the institutional economics framework: they can be considered as a primary coordinating mechanism of economic activities, alongside the role of price mechanisms in market transactions. Following North (1991, p. 97), all FSP can be considered as institutions, i.e. "*Institutions are the humanly devised constraints that structure political, economic, and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights)*".

Formal (legal) rules (see Fig. 7.1) are created by economic institutions (FSP—organization level) and political institutions (national and supra-national regulatory and supervisory authorities, governments—environmental level), whereas informal (cultural) norms are part of the heritage that we call culture. Culture is a social construct and is rooted in a nexus of meanings and assumptions: well-established and rooted deep in society, which are difficult to change. Moreover, culture, as a social construct, cannot be analysed effectively "from a distance", such as, for example, through mainstream economics or management studies conducted using surveys. Instead, for better results, research "from within" conducted using carefully constructed experiments and direct observation, may offer the greatest potential to enrich existing knowledge. At heart, the decision-making processes of FSP are intrinsically linked to the technologies they adopt and associated risks they face; while human capital dimensions are

	Informal Rules /Cultures	Formal Rules /Laws
Organization Level (internal)	1 Organizational /Corporate Cultures	3 Formalization of organizational systems (OD choices)
Environmental Level (external)	2 International/ National/ Local Cultures	4 International, supranational, national laws and rules

Fig. 7.1 Formal and informal coordinating mechanisms: an institutional framework (*Source* Authors' original figure)

strongly influenced by established norms and embedded culture. Thus, to fully understand the role of culture, it is also valuable to study contextually through the application of the contingency approach that is typical of some schools of organization and management studies.

In the case of FinTech culture, it's clear that the development of values coherent and apt to develop innovation is influenced by other rules and cultures, both external and internal, to every FSP. For example, the development of a positive cultural attitude towards FinTech innovation can be stimulated by effective regulation (these include an innovative and encouraging sandbox approach such as in the UK made possible through collaborative efforts between regulatory and supervisory bodies), by the level of digital culture of a country (at the European level a digital strategy has been defined) or of the specific local area (i.e. a geographical area with deep presence of hubs and accelerators) where the FSP is located (CCAF et al., 2020; Frost, 2020). Generally speaking, it is useful to take into consideration the internal and external profiles of rules and cultures: underlining that we use the word cultures while assuming that there can be a dominant culture; yet, in every FSP we can identify various subcultures (linked to business lines, gender, managerial level, job category, business process and work experiences, and so on). This is highly relevant since n FPS environments, external and internal choices about rules and cultures are strictly interrelated, in multiple and reciprocal directions, with different actors and stakeholders as decision-makers.

Taking into consideration the extremely wide impact of digital technology and FinTech on society, we have to consider the major characteristics and dynamics of the external environment (Sagiv & Schwartz, 2007), which can be divided into the legitimization environment and the task environment. The first refers to all stakeholders of an organization (Freeman, 1984), consistent with an institutional view of organizations (DiMaggio & Powell, 1994). FSP need to justify their activities to several groups of stakeholders: for example shareholders, authorities, customers, employees, suppliers and so on, who can also have conflicting interests. Considering Fintech innovation and adoption processes, ICT companies and consulting firms have important roles to play, especially in the face of traditional FI, just as customers do. FSP's actions (including the behaviour of employees within them and other relevant stakeholders) should be legitimized, i.e. seen as desirable and appropriate within some socially constructed system of norms, values, beliefs and definitions (Suchman, 1995, p. 574). The new financial services environment, from this point of view, is more favourable to emergent FinTechs and BigTechs who can offer improvements in speed, efficiency alongside more personalized customer-focused experiences and products. These attributes are increasingly diffused in many financial services market segments. Of course, people (employees) bring to banks and FSF their own perceptions of values (e.g. national, social, religious, managerial) regarding technology, as well as trust, fairness and other concepts and factors influencing their relationships with different stakeholders and their working contexts. Also, as previously mentioned, there are likely to be some key differences in culture and the type of employees working in traditional FI compared with NE, but so far we have no clear evidence of matching (or mismatching) between employees' values and stakeholders needs and values in either case.

The task environment, which relates to the environment the firm operates in and which influences its performance, is commonly defined by what is expected by "the market". Generally, FSP develop strategies to achieve certain tasks that are either profitable or guarantee survival. Their operations are directed at the successful accomplishment of tasks, and they are directly linked to the task environment in two ways:

a. through “actions,” influenced by organization design (OD) choices (these encompass not only technology but also processes and structures design, outsourcing and insourcing choices, people management tools and so on).
b. through “market feedback” as a response to operations. As operations are strongly linked to OD choices, these choices indirectly influence the link between operations and task environment. OD choices are (or should be) defined and set up by FSP and are (or should be) directed at satisfying stakeholders’ pressures and the demands of the market.

The extent and nature of competition between Traditional FI and NE (FinTechs and BigTechs) changed dramatically after 2008, driven by the rapid development and proliferation of FinTech innovation as well as evolving customer demands (Alt et al., 2018; Carbò-Valverde et al., Chapter Five, Figure 5.6). This is important since the framework we have outlined in this section argues for an increasing need to analyze the impact of FinTech in a deeper and a more holistic way, beyond stereotypes.

Traditional FI can experience considerable difficulties in adapting to the new FinTech ecosystem (a different definition of environment), because of their dominant (rigid, hierarchical) organizational cultures. However, some traditional FI players are working hard and investing heavily to try to address some of the difficulties they face in adapting to the new ecosystem. These include, especially, large banks in the systemically important (SIBs) category, but also small- and medium-sized traditional FI, who are developing more agile cultures through more flexible OD (the phenomenon of smart or agile working) and more attention to requested customer experience digital profiles. In terms of the external environments faced by traditional FIs and NEs, while there is considerable overlaps, there are distinction between external environments is not only linked to regulation and supervision, but to the power and the pressures of different stakeholders (shareholders, consumers, governments and public authorities).

Taking into consideration the organization level (internal environment) is vital for analyzing dynamic relationships among organizational culture, strategy, structure and operations of an organization, as well as the influences of OD, HRM and leadership on human behaviour (in general and with special regard to the FinTech adoption process), and then on corporate performance, and vice versa. Schein (1985) and Hatch

(1993) provide a theoretical basis for the development of the "internal environment" of an organization. Schein (1985) focuses strongly on the domains (assumptions, values, artefacts) of organizational culture, observable and not. Hatch (1993) adds one domain (symbols) and specifies four processes that link these domains. She states that there exist two possible ways in which observable behaviour emerges through underlying assumptions: (a) through "manifestation" into values and "realization" into artefacts and (b) through "interpretation" into symbols and through "symbolization" into artefacts. Taking into account the Fintech innovation processes (technology adoption through make or buy or partnership decisions; impact on different parts of the value chain, insourced and outsourced; creation or co-creation of new customer experiences), it remains unclear under which conditions such processes take place. It is also unclear as to what factors determine the path by which assumptions are transformed into artefacts, that is, when do assumptions become "manifested" and "realized" and when are assumptions "interpreted" and "symbolized."

The internal environment defines the specific working context of people (inside and outside the FSP) throughout the FinTech innovation processes, with deep consequences for the future of work in FSP. This will likely become even more important after the COVID-19 pandemic, which has highlighted a need for more effective digital competences (see further, Sect. 7.4). On the organization level, as usual, the *tone from the top* is very important. This means the dominant culture of top managers and members of the boards and how these are channeled throughout organizations. In fact, even if the apex of every organization is extremely relevant, change management and innovation processes are deeply influenced by assumptions, beliefs and actions of people working at lower levels of the organization, and by customers and suppliers.

7.3 Cultural and Organizational Challenges in Front of FinTech Innovation

Observing the FinTech innovation landscape through the lens of academic contributions, consulting firms reports and regulatory and supervisory authorities, we can find informative evidence on the following topics:

- The differing degrees of innovation and emerging need for changes in business models—not only in traditional banking terms, such as interest or fee-based businesses, retail or wholesale, but also in organizational systems of diversified or specialized FSPs;
- the increasing openness of the value chain in the financial services industry, including a need to update the traditional concept of the value chain introduced by management guru Michael Porter in the 1980s;
- FinTech innovations can have significant influence (impact) on different and diverse business processes. With some of the most affected including, but not limited to, marketing and sales, operations, compliance and risk management, and people management.

Some of these topics can be analyzed in light of the framework of the five strategic scenarios depicted by the Bank for International Settlements, presented in Chapter 6. Big questions to consider include: if a traditional FI must react to the attacks coming from NE (FinTech and BigTech), which cultural and organizational characteristics must be developed to stay well positioned in each of those scenarios? Moreover, do they need marginal changes or radical changes? Of course, as with every big question, there is rarely just one answer, especially given that the future of the competitive landscape is not very clear, and when we talk about competition we should have clear in mind the relative strategies, challenges and needs of both traditional FI and NE. From this point of view, we are currently at the beginning of efforts to clarify the competitive landscape. These early efforts have included efforts to obtain some insights from current secondary market data and through surveys (Petralia et al., 2019). Unfortunately, however, when we try and search for not the *why* and *what* of these processes, but are instead are interested about the *how*, few organizations seem willing to disclose the black box of cultures and organizing modes behind FinTech innovations. Clearly there is much scope for future research in this area.

One recent article by Gomber et al. (2018) attempts to identify the different kinds of FinTech innovations and the relative impacts and effects they have had, building on Pisano (2015), which itself was based on an influential article on innovation by Chesbrough (2003). Pisano (2015) presents a 2×2 matrix. The first dimension encompasses whether a new innovation permits the leveraging of existing competences or requires new technical competences in an organization, while the second dimension assesses whether an existing business model can be leveraged or a new business model must be created. In this matrix:

- routine innovation permits existing technical competences to be utilized within an existing business model;
- radical innovation allows firms to continue using existing business models, but also calls for a need to create new technical competences;
- disruptive innovation allows firms to continue using existing technical competences, but calls for the creation of a new business model.

Summarizing the impact of FinTech innovation, Gomber et al. (2018, p. 228) argue it "*fit*[s] *into both categories of innovation—radical and disruptive, yet many seem more well-suited to being recognized as what Pisano refers to as "architectural innovations; in other words, fintech innovations often involve new technical competences and a new business model for effective value appropriation*."

In Gomber et al. (2018, p. 229), two kinds of effects that the introduction of fintech innovations stimulate are considered. The first is based on how customer experience is affected by improvements in existing product functionality or by the introduction of new services and products. The second is based on whether new technology productive has complementary or disruptive effects on the existing competitive landscape—both in terms of the extent of products and services offered, but also in terms of competition between market players. The authors further highlight that older business models may require modest updates to incorporate updated processes, whereas new business models may be required to fully realize the impact of technologically driven change on firm performance and wider competitiveness. Gomber et al. (2018, p. 229) argue that distinguishing between these two effects (i.e. whether existing processes and functionality are suitable or new ones are required to support FSP) is possible by analyzing the customer experience dimension. The authors apply this framework to the following fintech innovation areas: financial services operations, payment services, deposit and lending services and financial market and investment-related services.

If we apply the framework Gomber et al. (2018) to business lines where innovative services are widely employed (see BCBS, 2018, p. 9, and also Thakor, 2020, p. 3), we have to also consider the need for changes in cultures and organizing modes in traditional FI, given that the new offerings of NE can establish new customer experiences (and hence expectations), and also when the scale of competitors is large or is becoming larger (for example the entry of tech giants to the sector). In retail payments and mortgage lending, traditional FI have so far faced the highest threats. Thus, there is perhaps a greater need to transform marketing and operations cultures and processes. More generally, we need to analyse the amount of investment and capital allocation within each business line of a diversified traditional FI in order to understand where changes are occurring, and when new business models, culture and organizing modes are needed. Take for asset and wealth management industry for example. Here the impact of enhanced customer experiences being delivered through innovative AI applications by FinTech, against a backdrop of very complex and volatile financial markets and disruptive effects from competition, has so far been underestimated by existing players. Ultimately, customer experience focused cultures and risk and compliance cultures, guided by tech-intensive processes, are essential for sustaining traditional business areas, and, for traditional FI, essential in order to avoid a future of being outcompeted by new entrants and existing players capable of embracing industry change.

Nevertheless, the strongest management idea behind the adaptation of FSP to FinTech innovation is based on the collaborative use of knowledge and competences through the organizational boundaries of traditional FI and NE: between them and with all, so-called, market support services providers. Henry Chesbrough (Chesbrough, 2017, p. 30), one of the fathers of open innovation management research, defines open innovation as being "*a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model. For those of us who remember spillovers in economics, the concept is similar. Those were unintended flows of knowledge, however; in the open innovation model, we purposively harness flows across organizational boundaries. The business model governs how and where that happens*". Such ideas are well captured in Dahlander and Gann (2010) who establish a matrix that sets up "flows" in terms of direction, inbound and outbound, and whether the motivations for flowing across organizational borders are pecuniary or nonpecuniary. "*The point of this structure is that all of these modes can be* *useful to think about as part of the open innovation model: bringing knowledge in or taking knowledge out, whether for monetary or nonmonetary purposes*" (Chesbrough, 2017, p. 30).

Under this approach to FinTech, as outlined by Dahlander and Gann (2010) and Chesbrough (2017) among others, innovation is fundamentally based on trust, flexibility and collaborative mindsets; open-minded people needed to manage innovation in such a way, and business models must be shaped to stimulate managers and professionals to act in a way consistent with a coherent and open innovation processes. High R&D expenses, business accelerators and hub establishment, and recruitment of human talent, are some organizational symptoms of the effort towards open innovation. The concept of value chain by Porter (1985), with customer interface at the end of the chain, can be replaced by a more customer-centric construct (Chesbrough, 2017, p. 31), that resembles a web: "*You need to design moments of truth, or experience points, where you and the customer interact, to assure that the product or service you're designing is, in fact, what the customer wants or needs. And not all of this goes on inside your own four walls. A lot of it sits outside the boundary of any particular firm, out in an ecosystem or a value network, with partners, complementary third parties, even investors*".

The service web recalls other concepts of the FinTech innovation ecosystem, the open-source development process, the crowdsourcing. The open innovation paradigm calls for new cultures, leadership styles and organization designs. Following a prescriptive approach, typical of consulting firms, the consulting firm McKinsey is very clear with respect to the need for organizational changes in traditional FI in order to cope with NE attackers: "*The typical organization chart of any bank will show a matrix of products and channels, with physical distribution usually leading in size and scope. The profits and losses (P&Ls) that accompany these matrices vest power in the owners of the channels and products that are most likely to be in the firing line of fintech attackers. These attackers are typically oriented to customer metrics tied directly to their financial performance*" (McKinsey & Company, 2016, p. 14).

Nevertheless, such organizational changes should be handled with care, taking into consideration an effective contingent approach to different FI in terms of governance, geographic location, strategic business portfolio and so on; most banks and other traditional FI have consensus-oriented cultures that are slow to follow external changes, so they should promote cultures that support faster decisions. It's necessary for banks and traditional FI to answer questions regarding innovations needed: the need for the development of incubators or of the creation of separate digital banks under separate brands, the usefulness of separate laboratories or of a venture-capitalist-like investment vehicle to be able to experiment with new technologies (McKinsey & Company, 2016, p. 14).

A recent report prepared by a consulting firm in collaboration with the World Economic Forum (Deloitte, 2020) underlines the implications of FinTech innovations on different business processes. Clusters of technologies enable different innovation pathways within financial services. These pathways have potential effects:

- on competitive dynamics (including greater focus on differentiation strategies across business lines);
- on breaking down old barriers, enhancing FSPs' knowledge of customers and, relatedly, developing improvements in the provision of personalized, tailored financial products and advice via a more complete understanding of customers across products and channels;
- on tackling systemic industry challenges. These include various cyber risks (attack to privacy, data breaches, and so on), as well as ethical, social and environmental challenges, that emerging technologies can create or exacerbate.

Marketing and sales, data management and operations, compliance and risk management, and people management are the most relevant business functions impacted by the possible consequences of technological innovations. The general challenge for all FSP, and especially traditional FIs, is to succeed in creating (or maintaining) ambidextrous organizations—able to gain two different objectives: exploration and exploitation (Duncan, 1976). Accordingly, successful ambidextrous firms should be equally capable of both (Lubatkin et al., 2006, p. 647). However, "*although OA* [organizational ambidexterity] *has been studied in a number of different industries and countries, there is one context as yet unexplored that may improve our understanding of how organizations engage in these two types of actions: the banking sector. This sector presents an ideal context in which to investigate OA, partly owing to its nature, size and importance, but also due to the regulatory constraints it faces vs. the scope of its mission, all of which affect the pursuit of new opportunities*" (Campanella et al., 2020,

p. 273). Clearly, future research is needed to explore the role of organizational ambidexterity in the context of the banking and wider financial sector given the unprecedented nature of transformation and disruption from FinTech in recent years.

7.4 Current and Future Issues Associated with Managing FinTech Cultures and Organizational Changes, Including Future Research Streams

In this final section of this chapter, we try to summarize the main issues emerging from the management of FinTech innovation by FSP. We do so by focusing more on traditional FI and providing qualitative comparison with NE (FinTech and BigTech). We finish by identifying potential future research streams that we believe will be useful in advancing current understanding as to how FinTech culture and organizational changes will evolve in the future.

These final considerations offered to the reader come from the authors' research and university teaching experiences on financial services strategies, from previous sections of this chapter, from a recent survey conducted about the impact of digitalization on FSP (Petralia et al., 2019) and from very recent reports regarding the future of work—also incorporating the effects of COVID-19 on working conditions and competitive landscapes (Altman et al., 2021; McKinsey Global Institute, 2021).

"*To gain insight on how competition is affecting the provision of primary bank functions, we conducted a short qualitative survey of market participants, including banks, nonbank financial institutions, FinTech firms and Big Tech firms. We received nearly 60 responses, about three-quarters of which were from large banks*" (Petralia et al., 2019, p. 28). The products and services included in the survey by Petralia et al. (2019) are typical of the main business lines covered by FSP, and have relationships with different parts of the value chain (including origination, back and middle office, service delivery).

The survey asked FSP to select the products and services that are most affected by technological developments *now* and that are likely most affected *over the next five years*, identifying those services that are seeing the greatest competition. Across all questions, payment services emerged as first, followed by payments as being most affected areas. Within these, the survey results also infer that products and services under maturity transformation and forms of information processing are both facing digital disruption. Under maturity transformation, retail lending also scored highly in all three categories. Retail lending (included consumer lending), being more standardized, was also identified as being more open to disruption than commercial lending (this is typically corporate relationship lending).

Although not necessarily considered traditionally core services of FIs' information processing categories and customer and channel management were the second most important product and service areas currently affected by technological developments. Regarding the evolution over next five years, many survey respondents believed that business intelligence and data analytics would assume the second-place position. Overall, there was a clear consensus that technology developments enable FSP to improve service quality and better understand customers' behaviour. Furthermore, great potential was seen in the use of algorithms and AI for improving business processes over time (e.g. regulatory and security controls), including Anti-money Laundering (AML) and Counter Financing Terrorism (CFT) compliance, and for improving success rates in detecting and preventing fraud.

More specifically, regarding the first question, many of the bank survey respondents considered digital transformation as a key priority going forward, which they expected to help deliver improvements in efficiency, products that better meet customer demands, increased agility in implementing new products and services, reducing the size of existing branch networks, and improved risk management and regulatory compliance. As to the second question, which asked bank participants to consider how the structure of FS industry may evolve over the next five years, respondents felt that the financial sector competitive landscape will become broader and more diverse with traditional players such as banks operating increasingly alongside FinTechs and BigTechs either as director competitors or in strategic partnerships. As to exactly how this will happen, survey participants seemed less certain. More specifically, while many believed a wave of consolidation would occur, there was considerable variation in who they thought the targets would be. A number of survey participants thought larger banks such as those in Europe and particularly those unable to evolve business models could be probable targets, while others believed small- and medium-sized banks would be more likely targets.

From this, it seems clear that there is already much awareness about the competitive future and existing players are starting to devote greater attention to preparing for it. Answers from the survey of Petralia et al. (2019) also closely resemble those of other surveys in the last five years. What is less clear, however, seems to be what the potential cultural and organizational consequences of FinTech disruption might be. Much clearer is that many operational and strategic risks are closely linked to technological innovations and with resultant competitive pressures. Table 7.1 provides a summary of some of the most interesting selected quotes from the respondents of the Petralia et al. (2019) survey.

With a view towards the future, banks (large ones) have both disadvantages and advantages compared to NEs. Relative advantages and disadvantages are tied to technology, knowledge of customers, size—with scale and scope effects, and policy-based factors (namely: prudential regulation, data privacy and protection, political and lobby power). From a managerial point of view, in front of FinTech innovation impacts, we should also place corporate cultures (some may be more or less supportive of innovation) and organizational design choices (that have important influences on cultures and people behaviour). Of course, NE have a number of significant technological advantages, which are supported by more agile cultures and organizing modes. In some business lines (payments and retail lending), NEs' can also have advantages in terms of time-to-market, better customer experiences offered, and more developed, sophisticated and innovative credit scoring tools. Conversely, large banks possess financial advantages stemming from size (cost of funding), but not networks effects if compared to BigTechs. They also have significant political lobbying advantages linked to a reputation of observing data privacy and protection rules—much more than NE. This chapter considers that banks should take care to preserve these advantages, taking in mind that the experience of consumers is paramount in a market economy. From this viewpoint, many NE are accumulating large advantages in terms of delivering high customer satisfaction, especially with retail consumers and younger generations.

When we talk about FSP culture and organizational change in front of FinTech innovation, we are debating about the behavioural reactions of people within organizations of different size, location, specialization, origin (traditional or digital born), within the financial services industry (FSI) or outside and trying to enter. Therefore, our attention must be devoted to the future of work in a digital world and to the competences

Table 7.1 Selected quotes from survey respondents

We are leveraging the best of our business—including data and analysis, deep industry insights and human capital—*to help people* build new skills, adapt and succeed in an ever-changing world of work
The current incumbent entities will have to transform themselves to compete with other companies, not only in the financial industry but also from other sectors, especially technological, in order to maintain customer relations and trust. This relationship is what allows the capture of interaction data to improve the service and allow a personalized offer. Only the banks that are prepared to compete in the digital world, leveraging the new technologies and offering data driven services to their customers will maintain their position
There will be a convergence of Big Tech, FinTech, and traditional financial services and this will follow a long period (~10 years) of *complex challenges; political, commercial and technological in character.* We also anticipate an exponential growth in the development of regulatory tools and approaches that will be both a driver of some of the changes in the financial system as well as reflecting *reactions* to it
There will continue to be the emergence of new FinTech companies, which will promote competition in the industry resulting in lower costs for the client… *We expect to see banks, including smaller banks* that may not have the resources to build internally, continuing to partner with tech firms as the costs and risks of doing so decrease, to improve their ability to service their customers, increase efficiencies and improve controls. *The ability to recognize economies of scale by leveraging FinTech services will allow small banks to remain competitive with larger banks. Small banks will also remain competitive through different cost structures, or by differentiating on product and services.* The players most likely to succeed are those that are best able to meet their clients' needs which means delivering to your client more, better, faster and quicker in one way or another, while balancing protecting their privacy and avoiding bad actors from engaging
The ubiquity and exponential growth of data has implications that are poorly understood. "More is different," as it's been said. With this new data, an ability to move it securely through the cloud at low cost, and with the rapid advance in machine learning/AI technologies, we will be increasingly more capable of discerning meaningful patterns in the data that provide heretofore unavailable insight in to a host of what are currently "unknown unknowns." *We're moving from Galileo to Hubble: the scope, scale and granularity of inquiry these new lenses on life make possible are difficult to fathom and even beg credulity—today*
Digital transformation is a priority for the bank. On top of improving efficiency, technological development has enabled the bank to improve its offer to customers, with a better understanding of their needs. *The bank maintains a mix of physical and digital channels that allow customers to choose how they relate with the bank:* in branches, remotely with personal advisors or through purely digital channels, being mobile is the most relevant of them

Source Adapted from Petralia et al. (2019, pp. 32–33) with *Italics* added for emphasis that people at work must possess and/or cultivate (and that FSP as organizations must help to develop). Important to this, we must consider FSPs as open work systems. This effectively means that FSPs, be they banks, asset management firms, online lending platforms or numerous others, must perform their tasks using the capabilities of both internal and external knowledge workers.

The importance of knowledge workers in helping create value is well established in the banking and financial sector and goes back hundreds of years. The increased emphasis on both internal and external workers is once emphasized by Altman et al. (2021):

> *Our research makes clear that most managers today consider employees and other workers who create value for the enterprise — including contractors, service providers, gig workers, and even software bots — to be part of their workforce. Our recent global executive survey affirms that the vast majority — about 87% — of respondents include some external workers when considering their workforce composition.*
>
> *At the same time, most workforce-related practices, systems, and processes focus on employees, not external workers. Workforce planning, talent acquisition, performance management, and compensation policies, for example, all tend to focus on full-time (and sometimes part-time) employees. Consequently, organizations often lack an integrated approach to managing a workforce in which external workers play a large role.* (Altman et al., 2021, p. 1)

In FSP, and with special regard to traditional FIs, the main concern is how to develop people management practices (recruitment, selection, rewards, careers, development, suitable for the new digital world, with the required flexibility and speed, while simultaneously maintaining high standards of employee welfare and buy-in—especially surrounding organizational changes and the integration of future innovations and sector developments. Unfortunately, history has taught us that change is a difficult process; above all, there are issues with transforming firm cultures and established norms. This difficulty is well established in management literature (not so much in finance and banking literatures), some of which make particular reference to FSI and the banking industry.

Based on the work of Altman et al. (2021, p. 16), we can see some possible changes in the workforce ecosystem, driven by, and a function of, developments in the FinTech ecosystem; keeping in mind that it is likely that banks are more likely to adopt a "traditional approach", or something closer to this than FinTechs and BigTechs. Regarding the people management systems of FSPs, digital competence gaps deserve greater attention going forward (Murawski et al., 2020). Given that digital strategies are extremely relevant for FSP— especially for traditional FI, hiring the right people to work within a digital environment is of central importance. Many banks see the digital talent gap widening, compared to other industries (e.g. automotive, retail, consumer products, telecom) and this has implications for future competitive dynamics and industry evolution. There is a need to think about what type of digital competences is needed and required in FSP. A useful framework is the DigComp 2.0 framework. It is well-known, up-to-date and it covers a wide range of competence areas. It has been used in numerous academic studies across different disciplines, and it allows comparability between both different occupations as well as studies conducted at different points of time. It was prepared for European citizens (Vuorikari et al., 2016), and it contains not only strictly technical (IT) competences, but competences needed for an effective usage of digital technologies (information and data literacy, communication and collaboration, digital content creation, safety and problem-solving).

As a final point, among the myriad and multifaceted impacts of FinTech innovation on FSP, there is a need to consider the huge development of remote working on the FSI—with recent acceleration driven by the worldwide COVID-19 pandemic. For example, while in the USA remote working has been largely restricted to several sectors, the broad financial sector has the greatest potential for remote working (McKinsey Global Institute, 2021). In fact, it is estimated that 75% of activities can be conducted remotely with no losses to firm productivity (McKinsey Global Institute, 2021). Due to limitations brought by the pandemic, remote working (called also smart working in some countries) has been utilized by FSPs all over the world. However, this sudden and unexpected shift has posed many problems for institutions in terms of organization of work processes, job satisfaction and morale. If it is true that the developments of ICT and other technologies make this kind of work possible, the main obstacles are due to the command-and-control styles still present in many traditional FI. Psychosocial and industrial relations aspects of work must be managed by FIs in such a way so as to compete with more digital educated work environments inherent to FinTechs and BigTechs.

7.5 Concluding Thoughts

In conclusion, this chapter has provided a comprehensive overview as to how culture and organizational design of FSPs are being impacted by the emergence of FinTech and BigTech. Yet, as we near the end of this chapter, it is important to take stock of what we know and what we do not, and it is important to emphasize that there is still much to learn about FinTech cultures and organizational changes in FSPs.

FSPs, especially large traditional and diversified banks (think about SIBs), must manage change in a balanced way through the exploitation of consolidated advantages (scale and scope economies, reputation and cost of funding) with innovation-generated opportunities offered by new emergent financial technologies. This means being ambidextrous, from a strategic point of view. Beginning at the top of organizations, future research should aim to study technological, OD and HRM competences and culture among board members and top management teams. This is important since it is those in the upper echelons of FSPs, who must select internal and external proposals to achieve multiple objectives and adopt a strategic approach towards FinTech opportunities and threats. Besides studying the impact of FinTech innovation on culture and organizational design from a upper echelons perspective, it would also be fruitful for future research to analyse the role of People Management (PM) or Human Resource Management (HRM) more broadly, as well as Organization Development, in managing the requirements and effects of adopted technological innovations. For instance, do they adapt function according to the evolving needs and impacts of technology innovations or do they play a central role from the beginning through direct input and collaboration in innovation projects? As for other management topics, there is a need to understand what the most effective role of HRM should be: strategic (medium and long-time horizon) or tactical (short-term), and whether a people-oriented or process-oriented (Ulrich, 1997) approach is most effective. It is our view that PM, HRM and OD must function as a change agent.

Many other questions about the decision processes involved in FinTech innovations in FSP also arise, which should guide the future research agenda. Of course, we could try to answer these questions by applying research methods such as those employed in longitudinal case studies, including the use of public information, interviews with personnel, and direct observation. Alternatively, researchers could make use of mixed research methods, and from a distance attempt to assess statistical relationships between expenses, investments and firm performance attributable to FinTech innovation, and, from within, by trying to understand internal managerial thought process and decision-making. Irrespective of methods, we propose the following list of questions that future researchers may wish to explore in order to increase understanding as to the role of organizational design and culture in the new FSP landscape (some of these apply to all FSPs, while otherwise they are specified):

- In addition to PM, HRM and OD, what roles do other support and business units play in helping harness the value of FinTech innovation?
- When managing innovations, do banks follow a "centralized approach" or a "differentiate, then integrate approach" (which affords greater flexibility and consideration of various business lines)?
- Are strong FinTech cultures developed predominately from within banks or from outside (by recruiting knowledge workers from FinTech and BigTechs)? Moreover, are the recruitment choices of FinTechs and BigTechs similar to banks, aside from banking and finance competences? And are different kinds of FSP sharing competences and building new hybrid FinTech cultures?
- How transformative and disruptive are FinTech innovations from the perspective of different stakeholders? Which stakeholders are more open to agile and digital working practices or are they more resistant to change, and what are the main reasons why?
- At what organizational levels have decisions and actions that created innovation successes and failures been taken in the recent past? Does top-down or bottom-up innovation dominate and does this vary by types of FSPs?
- Are innovation successes and failures mainly based on knowledge and competences developed inside or outside the bank?
- Do trade-offs (e.g. search for profit vs. cost reduction) exist in the Fintech innovations' adoption or instead are they only perceived?
- Is Fintech innovation seen as a priority by bank employees? This could be because rank and file bank employees perceive senior management as focused on customer needs and on creating future development paths (also through collaboration with FinTechs and BigTechs). Alternatively, do such employees view FinTech as a strategic risk and a potential threat to their continued employment?

- Are stakeholders' needs embedded—through measures and qualitative profiles—in FinTech innovations processes? Which stakeholders are more considered?
- Which domains of innovations are emphasized in change plans? Efficiency? Financial performance? Ethics and customer-centric assumptions and consequent values? And/or employees' digital competences development?
- How much is dialogue with regulators based on analysis of FinTech innovations and their impacts on performance and stakeholders' needs, and when?

Finally, it is clear that FinTech innovation is a very complex and systemic phenomenon, and the interested reader and research can find many other interesting and important questions worthy of future investigation. As stated at the beginning of this chapter, there is a need for an interdisciplinary and multi-party (academic, institutions, policy makers, etc.) perspective to be adopted, which brings together both academics and practitioner perspectives. For these reasons we encourage you to read again the quotes included in Table 7.1 and frame these with respective to the research questions we introduced in this final section, and to make your own reflections.

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CHAPTER 8

Digital Disruption: How the Financial Services Landscape Is Being Transformed

Walter Gontarek

8.1 The Potential Disruptive Power of FinTech

Almost exactly one year after the arrival of COVID-19 and its impact upon global economies, a senior banker made an extraordinary statement on a call with analysts.[1] JP Morgan Chase CEO and Chairman Jamie Dimon commented on the threat presented by FinTech by saying "Absolutely, we should be scared shitless about that…" and added that firms in the payments, bigtech and data sectors would offer brutal competition for years to come for banks.

His comments beg the question, if one of the most revered bankers in the world feels this way, what do incumbent banks, finance companies, insurers, wealth managers and the broader financial services industry at large think about FinTech? As of early 2021, FinTech valuations continue to rise, with large valuations for Klarna and Revolut muted (FinTech Futures, 2021; Transform Finance, 2021). Moreover, how did we reach

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the point where incumbent players—with seemingly strong brand and scale advantages, face a tangible challenge from upstarts? As an investor, board member and lecturer in FinTech, I have frequently questioned myself as to whether FinTech can truly live up to this promise. To begin to tackle this issue, I have drawn upon interviews with a network of FinTech leaders to gauge its disruptive power and better assess the attempt to digitalize financial services in a post pandemic world.

8.2 The Role of Financial Markets

From a theoretical perspective, the role of financial markets and its actors include the efficient allocation of capital, the extension of credit, and the provision of risk management products to hedge risks. But as noted by Saunders and Cornett (2018) and others, financial institutions also provide important payment or transaction banking services, deliver wealth management and financial advisory services, and serve a key link to central banks and bank supervisors given their regulated status.

Financial markets are from time-to-time subjected to shocks which interrupt their market position, including banking crises, regulatory intervention and now global pandemics. These shocks confound markets, create new opportunities for some, and have become a fertile ground for examination by academics. An exogenous shock certainly occurred in the financial markets following the global financial crisis of 2008/9, when a new breed of firm emerged in the financial services landscape, combining innovative means to exploit market gaps, efficiently operationalize customer experiences, and manage risks effectively. These firms developed innovative technologies, client-driven focussed approaches, and even fostered new cultures under the banner of financial technology firms, or FinTechs.

The world is gripped by another exogenous shock in the form of the global COVID-19 pandemic and its economic consequences, which is still shaping consumer and business behaviours, as they engage with financial services in seeking credit, wealth management, and transactional banking solutions.

8.3 Are Incumbent Financial Services Players Up to the Challenge?

Traditional financial services players face challenges on many fronts, including regulatory, reputational, and efficiency issues. Some incumbents have made great strides in these areas, yet substantial headwinds remain for many financial institutions. To begin, regulators hit banks with a near record of $10 billion of fines in the 15-month period through 2019 for money laundering alone (Fortune Magazine, 2020). As banks seek to tackle these challenges, compliance costs rise for many banks which effectively curtail innovation (American Banker, 2018).

Financial institutions have not always covered themselves in glory in terms of reputation, with episodes of mis-selling reported such as the Wells Fargo Cross-Selling scandal (Tayan, 2016). Fines, litigation, corporate governance failures and regulatory engagement causes widespread reputational damage and loss of public trust (G30, 2015). Ten years after the Global Financial Crisis or "GFC" of 2007/8, the Edelman Trust Barometer reports a 57% trust factor for Financial Services, the lowest score among the 15 industries reported (Edelman, 2020). New players are well positioned to take on new market share with a clean reputational scorecard unlike the incumbents. Yang (2020) examines the role of trust in consumers of financial services providers and using a differences-in-differences approach, empirically provides evidence of a causal relationship between low trust in incumbent providers and FinTech adoption.

Regulators have played an increasingly obtrusive role in the lifeblood of global financial institutions. As a simple proxy, it is interesting to note the number of times that terms such as "shall", "must", "prohibited" and "required" were used in US regulatory codes for banking rose significantly after the GFC, from 28,000 to over 50,000 per year by 2016 (WSJ, 2017). More recently, Dodd-Frank (US) in 2010, CRD IV (Europe) in 2013, and the Senior Managers Regime (UK) in 2016 are examples of the acceleration of regulatory engagement. These developments embed greater cost structures in the operating model.

Financial institutions are under pressure to improve their performance and efficiency levels. New market entrants erode the incumbent customer base and can reduce revenues. Further, bank credit losses from the global pandemic may reach 3% of total loans, further impacting performance (Deloittes, 2020a). While the impact of greater regulation and its relation to efficiency is an empirical question, intuitively one can see how greater supervisory restrictions limit economies of scale, growth and innovation. Barth et al. (2013) report that more restrictive regulatory environments are associated with reduced efficiency. Greater regulation is likely to drive banks to hold more capital in the future. Banks must pull-off a difficult feat in dramatically increasing customer experience to sustain revenues while radically reducing costs. Boosting ROE to an average of 12% for the world's largest banks calls for a cost reduction estimated at $200 billion (E&Y, 2020).

FinTech can be harnessed by banks in order to improve performance. McKinsey (2019) presents four levers to maximize productivity, including managing revenues, applying digitalization and automation (including natural language processing, robotic processes, chatbots), employing advanced analytics (including machine learning to decision processes), and greater management of human capital and conduct. While financial institutions face real challenges, FinTech applications can be used by incumbents towards greater efficiency over time.

8.4 Fintechs Embrace Disruptive Technologies and Applications

FinTechs, more so than incumbent firms, appear to quickly adopt innovative and disruptive technologies. FinTech can facilitate the customer journey and client prospecting. With low returns on ordinary deposit products, new investment products can be developed and delivered via digital means, driving a change in traditional sales processes for the prospecting, acquisition and retention of digitally savvy clients.

Susanne Chishti, CEO of FINTECH Circle and Co-Editor of the FINTECH book, added in an interview with the author: "AI and Big Data can drive improved customer experience and greater revenues. Predictive tools can inform risk managers to improve compliance, conduct and risk profiles, protecting franchise and brand value. Adopting the right technology facilitates business scale objectives and gives firms an edge over the competition". Cloud-based solutions, AI/machine learning and data analytics, payments, credit products, InsurTech and other concepts are now examined as disruptive technologies and settings (Fig. 8.1).

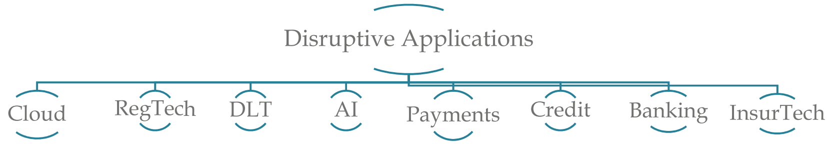

Fig. 8.1 Disruptive applications in FinTech (*Source* Author compiled)

8.5 Cloud Computing

Cloud-based technologies enable faster and more efficient development of data and programming solutions, providing large and small firms both flexibility and cost savings. Hon and Millard (2018) define cloud computing as "the use of computing resources accessed via web browser but actually installed and running on remote cloud servers".

Cloud-related spending grew 37% YOY to $29 billion during the first quarter of 2020 (PWC, 2020). While many firms implement full scale Software-as-a-Service (SaaS) solutions, others fail to embrace complete digital transformation. Cloud-computing can reduce development timing, facilitate scale-up of technology processes and cut overall technology costs. Also, financial services firms can quickly innovate with specialized externally acquired services and leverage industry-specific solutions. Related to cloud computing is the concept of "DevOps".

DevOps is a new approach to optimize and manage end-to-end service delivery and operations, applying a set of principles to transform the entire software delivery lifecycle including continuous integration, testing, delivery and support (Deloittes, 2020b). In an interview with the author, David Allcock, CTO at Channel explains "It's about having a set of working practices that accelerate the roll-out of system changes into the production environment while also trying to guarantee that code quality remains high. The cloud allows you to easily have distributed teams working closely together in DevOps fashion, while also providing the infrastructure, bandwidth and tools required". The DevOps operating model framework, combined with cloud-based technology, facilitates both planned demand (for planned projects) and unplanned requirements including service requests, and urgent updates (McKinsey, 2018).

Cloud-computing is increasing rapidly. "Only several years ago, storing data outside the physical location of any financial institution seemed impractical, un-necessary and even impossible. However, as the costs for hosting decline combined with the recent pandemic which fuelled further digitization of commerce of all sorts, the accessibility of secure and flexible cloud-based options have grown for financial services firms", explains Susanne Chishti, of FINTECH CIRCLE.

Providers such as AWS, Microsoft Azure and Google Cloud (Cloud Service Providers or CSPs) typically provide three types of cloud services. First, Software-as-a-Service (SaaS) is one common solution. In SaaS, the CSP satisfies all networking, servers, data storage and interface needs for clients. In order to better appreciate one application of the cloud, I have reached out to André Casterman, a non-executive director at Tradeteq and previously a senior executive for supply chain at SWIFT to focus on the global trade finance market. "The trade finance market has the potential to adopt SaaS services to bridge the gap between banks who want to risk-share and distribute client transactions and institutional investors who seek attractive risk-adjusted returns. Data integrity, technology and standardized or at least semi-standardized transaction features combined with cloud-based hosting can give institutional investors unparalleled access to this asset class in a centrally managed solution", Casterman explains.

Platform-as-a-Service (PaaS) is another type of cloud service. PaaS also provides a similar structure as SaaS but here the CSP also maintains all database and webserver functions while the client or application developer manages and controls their own applications. Lastly, Infrastructure-as-a-Service (IaaS) allows businesses to buy servers, software, network equipment, APIs or data as a fully outsourced model.

Together Finance BV is an Amsterdam-based technology-enabled provider of working capital to European SMEs. It has hosted its business in the cloud for several years, facilitating SME invoice data needs, risk governance and monitoring including AI-driven liquidity measures, and the provision of client and investor reporting. The author interviewed Mo Irshaid, Head of Transformation, to learn more about the role of the cloud at Togather Finance: "Legacy enterprise applications are managed by customised IT systems each with its own configuration of data storage, analysis and networks, so ever-increasing human resources are required to maintain these platforms, provide testing and maintenance. Because we are cloud-based, the required level of standardisation is much easier to achieve and maintain which reduces development timing and lowers costs".

While commercial banks in Europe may still dominate SME financing, there remains an unmet financing gap where the incumbents are not yet satisfying demands fully. SME financing gaps remain highest in the Netherlands (22% of GDP), Belgium (14%), France (9%) and Italy (4%), potentially leading to a constraint on growth (Euler, 2019). FinTechs and other technology-enabled firms, without legacy technology systems, are able to embrace cloud-based solutions to develop new applications and thus exploit specific market needs. In the examples noted above, we also begin to see the "bundling" of at least two technologies by FinTechs, cloud-based platforms and AI, a theme which will be observed throughout this chapter.

8.6 Regtech Responds to the Call for Greater Compliance

Regulatory Technology or "RegTech", which assists financial services players in better managing their regulatory position, is a fast-growing segment. Regulatory changes are being introduced at a rapid pace, and RegTech is playing an increasingly important role in helping banks, non-banks, asset managers, and insurers in managing these requirements in real time. Better information leads to better decision making, reduces compliance and fraud risk, and may reduce capital and expenses. RegTech not only helps firms better meet their regulatory obligations, but also assists global supervisors in performing their roles too. Common solutions may relate to managing fraud risk, Payment Service Directives, MiFID II, GDPR, AML/KYC, risk appetite articulation, and governance processes.[2]

One firm in the spotlight is Elucidate, which scores, reports and manages financial crime risks. This German-based RegTech rests on a blockchain-enabled platform to deliver tools to self-assess and report compliance needs within banks and their correspondent networks. Elucidate CEO Shane Riedel notes that "Banks spend $1.5 trillion to combat financial crime, often with limited success. We provide a 360-degree financial crime risk quantification and monitoring platform to mitigate and prices these risks for banks, non-banks and other players. We not only automate risk assessment and monitor affiliate risks, but our clients can lower payment and compliance costs and implement risk-based pricing based on their data".

Another firm operating in the RegTech arena is Neotas. It provides enhanced due diligence for finance, customer onboarding, investment due diligence and recruitment using data harvested from social media and the deep web to provide insights into people and companies at high speed and low cost. Ian Howard, Director, explains "Powered by AI and machine learning, Neotas goes beyond traditional database checks by analysing publicly available information including non-financial information to provide true background insights, networks and behaviours. We deliver this on-going risk monitoring with secure client portals and dashboards to inform better risk, investment and recruiting decisions by global financial institutions, NGOs, executive search firms and governments".

8.7 Blockchain and DLT

As discussed in an earlier chapter of this book, Blockchain and Distributed Ledger Technology (DLT) are becoming significant enablers in transaction banking and insurance sectors. It is a means of storing and transferring information without a centralized system or authority and is well known to power digital or cryptocurrencies. Its decentralized structure relies on a series of linearly connected blocks and is validated by a decentralized process called consensus (where no single trusted party can administer the blockchain) leading to each record to be immutable and not changeable. Immutability is key as it speaks to the trust embedded in digital assets where once stored, the data cannot be changed. Yermack (2017) demonstrates why it is difficult to cheat at Bitcoin. This is because one actor that wants to cheat in one block would have to complete difficult computations for related blocks and suffer expensive computing costs to complete this computation before others in the network finish the current block. Blockchain and DLT may be an effective workhorse with large volumes of data which need to store effectively and with great accuracy, such as trade finance or syndicated lending markets.

One sector that DLT offers promise is the settlement of telecom payments. Jeff Mason, CEO of TessPay, notes that settlement risk is a serious issue in the wholesale telecom sector. "In order to connect calls between different countries, different carriers are involved in the international supply chain using voice over internet protocol (VOIP) technology. Many of the participating international carriers are small-to-medium sized businesses for whom establishing credit is the principal challenge. That is where TessPay comes in to ensure the accuracy of cash settlements and controls are in place using smart contracts to ensure secure contract execution over thousands of transactions in a secure manner". The benefits of DLT here are clear, they drive down costs, increase efficiency and accuracy and may reduce operational errors.

Related to DLT are smart contracts, such as those found on the Ethereum blockchain. Smart contracts are blockchain-based self-executing code that will automatically implement the legal terms of an agreement, thus streamlining processes. They represent a progression from storing data to an all-purpose actionable utility. Smart contracts can (self) execute an action when the conditions of a contract are met for recurring contractual matters without the need of a third-party intermediary, driving costs down and accuracy up. But unlike DLT alone, smart contracts do more than report data, but can carry out pre-programmed actions such as derivative clearing and related cash settlements, insurance claims and pay out funds for transaction banking.

Clause is one firm that is disrupting contracting in the financial services, insurance and health care markets. Legal agreements in these domains are well known to be complex and time consuming. "Our mission at Clause is to transition the world to smart agreements. An effective smart contract can validate the completion of data inputs and automate the business processes that follow, including payments, notifications and reports, all from within the smart contract itself. Clients that use Clause find they close deals faster and automate processes more effectively using their enterprise software", explains Dan Selman, Co-Founder and CTO at Clause.

8.8 Artificial Intelligence and Machine Learning

This may be the decade for AI, machine learning and data analytics. Artificial Intelligence (AI) is defined as the ability to perform cognitive functions that are typically associated with the human mind, including learning and problem solving. The broader AI landscape includes robotics, virtual agents (providing a basic level triage of customer requests with pre-set replies to certain keywords or prompts) and machine learning (ML). ML algorithms detect patterns across large data sets to make predictions and recommendations, which is different from triggering explicit commands. Deep learning is a type of ML where interconnected calculators known as neuronal networks process vast data sets to make determinations about image designs, facial or voice recognition, for example.

One application for machine learning in financial services is risk analysis. Migrations.ml of Toronto Canada uses ML to analyze risk analysis requirements for public and private debt markets. Duncan Rowland, Founder and CEO notes that "Migrations.ml provides predictive credit analytics for nearly 5,000 corporate bond issues in North American credit markets, providing risk tools to inform banks, insurance companies, and other investors".

Artificial intelligence can also be deployed for improved credit analytics. Edward Altman, Professor Emeritus at NYU Stern is known for the development of the Altman Z-score (1968) and is a pioneer for building risk management and bankruptcy prediction models. Altman and Dr. Gabriele Sabato, a risk management expert and bank executive teamed up to launch Wiserfunding, which provides SME credit risk adjudication focussing on global SMEs. Using APIs, AI and other data analytics, it takes unstructured big data, and transforms this data into structured variables for model inputs, including qualitative information, social media and press data. This further improves the prediction accuracy of its models. "Wiserfunding generates a comprehensive risk assessment report including multi-year trends such as the SME Z-score, probability of default, loss given default and bond rating equivalents, including peer benchmarking to inform better credit decisions for our clients. During and post the pandemic, staying on top of SME credit risk profiles will be an important differentiator for credit-granting institutions", Sabato reportes.

8.9 Payments

Incumbents are under threat in the payments arena. As banks grapple with their own issues, consumer and business behaviour patterns are now changing along with broader technology and cultural trends. Payment solutions are all about making money move in secure, fast and simple means for consumers and businesses. Non-cash payments have increased due to the adoption of digital payment services and has been given a major boost during the pandemic when customers sought easy automated means to transfer funds. For example, Ripple deploys its blockchain and DLT technology to securely process payments across its RippleNet network efficiently. Each payment is encrypted using blockchain technology for money transfers to be secure, efficient and easily traceable.

In the UK, ClearBank is using cloud technology to transform the way payments are made as the first new clearing bank in over 200-years. Traditionally, clearing banks clear payments for regulated financial institutions including banks, building societies, SWIFT, MasterCard, Visa, and CHAPS. "ClearBank is changing the way payments are made by relying on a cloud-based platform to allow any authorised third party to access the UK clearing system via an API plugin in less than 8-weeks, thus facilitating real time payments", notes Charles McManus, ClearBank CEO. Firms such as GoCardless and TransferWise have announced significant business and valuation gains given the pandemic shift towards digitalization of payments activities. In the above mentioned examples and interviews, we observe FinTechs bundling different technologies including APIs, AI and cloud-based platforms to improve customer experience, increase efficiency and reduce costs.

8.10 Credit Markets Disrupted

FinTechs are busy disrupting the allocation of credit. Working capital is the lifeblood for any corporation. One firm seeking to disrupt working capital is Accelerated Payments in Ireland. "Accelerated Payments was created by entrepreneurs who know the importance of working capital management and just how important some invoices are to managing cashflow—we solve that hurdle and can reduce debtor days risk to zero. Accelerated Payments approves debtors in advance and after e-invoicing platform verification, clients choose the relevant invoices for funding and settlement", explains Ian Duffy, Accelerated Payments CEO.

The pandemic period impacted the supply chain and related financing needs. Inventory levels fluctuated as just-in-time supply chains were disrupted, banks re-assessed their appetite for working capital finance, and government funding programmes were designed to support firms, but may have crowded out some existing products. Take Italian digital lender Credimi, which advanced more than EUR 650 million in funding during 2020. "We first worked closely with local authorities to supply loans to clients backed by Italian state guarantees, and in early 2021 we launched Credimi Subito, which is designed for very small businesses that are most affected by COVID-19 and require rapid credit approvals." Noted Luca Bottone, Chief Lending and Risk Models Officer at Credimi in Milan.

Credit products are now embedded where purchase decisions take place, meaning a visit to a bricks and mortar branch or store credit department is no longer necessary today. FinTechs such as Klarna, based in Sweden, finance e-commerce transactions and claim to provide payment and financing solutions to some 90 million consumers for 200,000 merchants across 17 countries (Klarna, 2021). Tom Williams, CEO of

Certua, a UK-based technology firm that embeds digital financial services, tells us that integrating finance and technology to better manage the movement of working capital is particularly important in merchant finance during and after the global pandemic. “We integrate these applications for our partners including open banking, APIs and risk adjudication tools to facilitate user engagement, maximize differentiation and drive revenue growth”.

8.11 Digital Banking

Digital banks (also called sometimes neobanks or challengers) are transforming the banking experience, offering a wider array of choices to consumers and businesses. In 1967 in Enfield UK, Barclays Bank offered a cash machine to its customers as one of the early examples of an ATM machine, making cash available anytime. FinTech today takes a similar leap, empowering customers with data and tools to make better financial decisions anytime and anywhere.

SMEs are one specific market opportunity that is underserved by the incumbents. In response to that gap, certain players have focussed on this market rather than offer a wider array of consumer and business services. One such player is UK FinTech success story, OakNorth (NS Banking, 2019). OakNorth, commonly referred to as a neobank, maintained a disciplined underwriting approach and narrow customer focus to excel at SME lending while reporting profitability and valuation gains. It also leverages and licences their core technology offering overseas to reach broader geographies. Niv Subramanian, an early executive at OakNorth and a leader in FinTech markets explains: “When you start with an underserved marketplace and are solving problems for mid-market SMEs—which is a focused market niche—sound underwriting and robust credit analytics takes one a long way.”

Solarisbank in another FinTech leader of note based in Germany, successfully introduced its BaaS model, but with a twist, with a full banking licence. Clients of this platform connect via API to facilitate transactions such as loans, money transfers and other banking services. The idea is to create building blocks where its partners can create financial products, by accessing the Solarisbank platform across Europe. The pandemic has only accelerated consumer preferences to access financial services online with account support in-app and online chat facilities, facilitating payments, foreign-exchange, transfers, current accounts, and access to a suite of credit products in one digital setting.

8.12 Insurtech

Insurance is another market sector being disrupted by FinTech. Known as InsurTech, the provision of technology-enabled insurance services, firms like Claider, Cloud Insurance, Lemonade and Nimbla are disrupting this part of the financial services industry with solutions for specific underserved insurance sectors. InsurTech is disrupting the traditional incumbent insurance markets by driving greater efficiencies in terms of exploiting loss data or improved means of new client acquisition by seeking out underserved clients (whom may be more digitally savvy, as noted below).

InsurTechs have emerged across the P&C, health, life and trade credit insurance sectors. These FinTechs differ from incumbents in a variety of practices. InsurTechs exploit their expertise to engage with clients via digital channels, focus on focussed client sectors, automate product offerings, and offer data-driven insights on risk assessment and pricing practices (McKinsey, 2017).

Engaging via digital channels is one such example. Lemonade (NYSE: LMND) is a US-based insurance company with over 1 million insurance customers in the US and Europe using chatbots to provide insurance policies and handle insurance claims promptly. Lemonade also pursues a social mission and is registered as a public benefit corporation, offering the Lemonade Giveback concept. It offers clients the opportunity to donate excess premiums (not required for losses) to non-profits or charities as determined by users (Lemonade, 2021).

Empirical research has shown that younger firms face difficulty in accessing traditional finance and need to resort to the trade credit market for working capital (Canto-Cuevas et al., 2019). However, these firms may find accessing trade credit insurance to be a non-trivial matter. The author interviewed the CEO of another InsurTech to understand how it was exploiting unmet demand for trade credit insurance markets.

Flemming Bengtsen, the Founder & CEO of Nimbla, explains that efforts to distribute trade credit insurance to SMEs has been a long-standing challenge for large underwriters. "Supply chains are a major source of uncertainty and invoice financing increasingly requires trade credit insurance. However, many SMEs find traditional trade credit policy burdensome and complex to administer. We solve that issue with automated underwriting, a fully digital product from quote-to-claim, and further leverage of our data lake for real time financial and accounting data. Better data means better underwriting decisions. Our clients realise improvements in efficiency, and risk management decisions can be enhanced with our analytics, driving real cost savings".

8.13 Stakeholders in the Fintech Ecosystem

Prudential regulations for commercial banks provide capital, liquidity, governance and incentivization guidelines. These requirements are often institution focussed, that is they include all activities consolidated within a bank holding company or group. This has implications for firms' regulatory compliance. For example, a factoring subsidiary of a large European bank would be captured by these rules, whereas its non-bank competitor may not be covered to the same extent by prudential regulations, implying little adjustments have been made to cover the same activities in the fabric across financial services firms (BIS, 2021).

However, many non-bank FinTechs may seek to acquire a regulatory approval or licence for limited activities. How long this regime remains in effect may be determined in part by FinTechs, who can provide a positive contribution to lowering costs and improving efficiency for businesses and consumers alike, while also increasing the quality of overall customer experience.

Regulators have been generally supportive to FinTech. Progressive policies include regulatory sandboxes, FinTech accelerators, and the encouragement of data protection schemes to permit accessing and sharing consumer or business data. With the introduction of the Revised Payment Service Directive in Europe (PSD), banks are incentivized to open up their data to third-parties and thus paving the way to open banking. Specifically, openness and greater competition in banking are driven by providing bank account data to FinTechs and other third-parties in the EU and the UK.

Nearly 100 firms have been accepted to join the UK Financial Conduct Authority regulatory sandbox scheme, permitting them to test innovative FinTech products and services, providing a degree of customer and stakeholder legitimacy and confidence (Deloittes, 2018). Also, in the UK, schemes such as the Enterprise Investment Scheme, the Seed Enterprise Investment Scheme, and Entrepreneurs Relief incentivize investment capital into the sector.

Newly established challenger banks, including neobanks which provide specialized personal and business financial services often in a digital-friendly format. On the back of UK government efforts to stimulate a more competitive banking environment, these new banking entrants in the UK and across Europe build competitive and focussed savings platforms and niche lending businesses. Well prepared challenger bank aspirants often find supportive regulators and a dedicated new Start-Up Unit with simplified and streamlined bank charter processes and a relaxation for extensive liquidity and capital requirements (KRBA, 2018).

Regulators in other jurisdictions have also adapted to the emergence of FinTech, with the Central Bank of Ireland announcing an Innovation Hub for start-ups and established players,[3] the Monetary Authority in Singapore (MAS) fostering a FinTech Festival for leading players,[4] and the French AMF creating a FinTech, Innovation and Competitiveness Division to address and evaluate industry trends.[5]

Commercial banks and funds are important stakeholders in the FinTech ecosystem, as mentioned above, as sources of capital. Silicon Valley Bank (SVB) is one of the few banks dedicated to FinTechs, calling itself the bank of choice for the sector. It claims that nearly 80% of the Forbes FinTech 50 have banked with SVB. It offers or arranges venture debt, warehouse lending, payments processing and compliance support to its clients. The payments support is possibly key, as setting up bank accounts for new FinTech start-ups should not be taken lightly. It also supports public and late stage private companies for their capital raising efforts.

ABN AMRO Ventures and Santander InnoVentures are two providers of venture and early stage capital for FinTech start-ups, having invested in FinTechs including Tradeshift, Digital Asset Holdings, Kabbage, Ripple and others. Funds operating in FinTech markets include Finch Capital, Speedinvest, NFT, Index Ventures and Seedcamp, among others (Fig. 8.2).

8.14 Conclusion

Through the lens of a FinTech investor, board member, and university lecturer, a practitioner's view of FinTech is presented in this chapter. It examines the limitations of incumbent players operating in today's financial services market and how FinTechs embrace innovative and disruptive technologies to exploit focussed market niches.

Fig. 8.2 A conceptual diagram of the FinTech ecosystem with selected actors (*Source* The Author)

A revolution is underway in global financial services markets serving consumers and businesses today. The traditional supermarket model to acquire and cross-sell services followed by some incumbents is now increasingly being challenged by a new digitally-enabled model. FinTechs lure away digitally savvy clients, tempted by improved customer experience, greater efficiency and lower cost structures. We have also seen that in many cases, FinTechs are bundling several technologies at once such as cloud computing, APIs and AI, to provide better customer experience, reduce client prospecting costs and gain greater risk insights.

The regulatory environment for FinTechs has provided a friendly backdrop to the newcomers. Regulatory initiatives such as open banking which open up rich data sources to FinTechs which may further challenge the incumbents. Some regulators, such as in the UK, have also created regulatory sandboxes and specialist units to make the regulatory application process more accessible to FinTechs.

The future appears bright for those FinTechs which can harness disruptive technologies in specific sectors in order to deliver a digital customer experience, improve efficiency and reduce costs. One of the new themes emerging in FinTech directly related to the disruptive technologies examined in this chapter is "embedded finance" where FinTech or technology is integrated with other activities to digitalize an offering (Finextra, 2020). Examples are numerous in the e-commerce, point-of-sale and telco vendors in both B2B and B2C sectors. The ability of cloud-based solutions drawing on SaaS or BaaS technologies combined with APIs can drive embedded finance solutions with user-friendly data, attractive pricing and digital payment journeys.

Over 96% of US consumers are aware of FinTech providers and 64% of global consumers use FinTech (E&Y, 2019). However, FinTechs may also consider the earlier lessons faced by the incumbents, that trust is a key factor in the provision of valued financial services regardless of the extent of digitalization.

Notes

1. See JP Morgan earnings call transcript available at: https://www.fool.com/earnings/call-transcripts/2021/01/15/jpmorgan-chase-jpm-q4-2020-earnings-call-transcrip/. Accessed January 29, 2021.
2. MiFID II became largely effective in January 2018 and covers a vast array of financial products and activities including debt, structured products, exchange traded derivatives, investment advisors, investor reporting and investor protection for EU member states. GDPR or the General Data Protection Regulation is a EU law relating to data protection and privacy and addresses the transfer of this data outside the EU in international business. AML/KYC refers to Anti-money laundering describes the control framework that financial institutions of all sorts must adhere to prevent, detect, and report money-laundering. KYC refers to Know Your Client guidelines that require financial institutions to make an effort to verify the identity, suitability and risks involved with maintaining business relationships.
3. See https://www.centralbank.ie/regulation/innovation-hub for more information.
4. See https://www.FinTechfestival.sg/FinTech-awards.
5. https://www.amf-france.org/en/news-publications/news-releases/amf-news-releases/amf-announces-creation-FinTech-innovation-and-competitiveness-division-headed-franck-guiader.

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CHAPTER 9

FinTech and Regulation: From Start to Boost—A New Framework in the Financial Services Industry. Where Is the Market Going? Too Early to Say

Anna Omarini

9.1 Introduction

Fundamental and transformative changes have affected financial markets over the past two decades. In illustration, BCG (2021, p. 11) cite developments in US banking: digital-only banks now represent around 7 per cent of consumer liquid deposits and digital lenders around 40 per cent of unsecured personal loans; non-bank (including digital) lenders originate over 35 per cent of mortgages with Quicken Loans becoming the largest originator in 2020. In explanation, BCG (2021, p. 11) notes that *(…) Customers have embraced digital models across industries, the best of which*

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have created premium new experiences rather than simply re-creating traditional ones digitally. At the same time, incumbent banks lag with respect to customer engagement making them vulnerable to new competitors. (…) The current COVID-19 pandemic has further accelerated customer trust in and adoption of digital. In a recent survey over 50 per cent of consumers said they had increased their usage of digital channels during COVID-19. 90 per cent of consumers said they would continue to do so after the pandemic.

A recent retail-banking survey adds further perspective. BCG (2021, p. 11) reports *that an average of 13 per cent of respondents in 16 major markets used online banking for the first time during the pandemic (12 per cent for mobile)—and in some markets, the percentage is substantially higher. More than 20 per cent of respondents said that they have increased their use of digital payment solutions, such as those provided by internet banking and third-party apps, and more than 10 per cent said the same about credit and debit cards.*

The evidence shows the financial services industry is undertaking a deep transformation, which is taking place in different ways and for different reasons. Product innovation, digital channels evolution, and new legal frameworks are all boosting the introduction of innovative business paradigms in the market, such as, open banking and its related expressions. Different countries are moving in the same direction and undertaking similar transformations, as the whole financial industry becomes more adaptable and malleable to changes.

Ensuring a proper working of competitive market forces is considered one of the main reasons for open banking (*alias* PSD2) in Europe and other countries, where the goal of promoting competition in financial services is an explicit component of the regulator's mandate.

Collaboration with new financial services providers and partnerships might prove to be the future for the industry under an ongoing open innovation framework (Chesbrough, 2003, 2006, 2011). As a result, the market is experiencing opportunities, challenges, and risks, both old ones related to business as usual, and new ones from the "new normal", such as those related to the use of third-party providers for cloud, and from a more pervasive digital environment where data privacy, data protection, and cyber risks are some of these new threats impacting reputational risks and business resiliency.

Developments are confronting authorities and regulators with a big issue; namely, how to balance innovation, stability, and competition while maintaining consumers' trust. This is causing regulators not only to consider systemic risk arising from "too-big-to-fail", which refers to a few large financial intermediaries, but also to the systemic threat from an ongoing degree of interdependencies among new providers and incumbents—from inside the industry and outside because competitors come from multiple vectors. The big game, now, is one of "too-linked-to-fail" as well as an increasingly decentralized finance. On this point, it is interesting what JPMorgan Chase Chief Jamie Dimon, in his annual letter to shareholders (2021), wrote:

> *Banks already compete against a large and powerful shadow banking system. And they are facing extensive competition from Silicon Valley, both in the form of FinTechs and Big Tech companies (Amazon, Apple, Facebook, Google and now Walmart), that is here to stay. As the importance of cloud, AI and digital platforms grows, this competition will become even more formidable. As a result, banks are playing an increasingly smaller role in the financial system. I am completely in favor of open competition, and much of the competition that I cover in this section will be good. (…) As our system changes, our government and regulators need to understand that maintaining the vibrancy, safety and soundness of this system is critical – and this includes maintaining a relatively fair and balanced playing field.*

This draws attention to a critical issue concerning how to assess the roles of FinTech firms and banks in the market. FinTech firms are here to stay in different ways, not only as single entities, but as enablers of a deep change in the way banking is done now and in the future. This is because FinTechs are becoming more and more part of the economy and integrated, if not their services embedded, in everyday banking. Many new competitors have done a terrific job in easing customers' pain points in their banking and making digital platforms slick and simple to use. However, they have also benefited from differences in the regulatory playing field.

The chapter proceeds as follows: Sect. 9.2 outlines the recent banking transformation; Sect. 9.3 examines the issue challenging regulators to balance innovation and stability; Sect. 9.4 concludes.

9.2 Setting the Scene: Banking Under Deep Transformation

The increasingly unsettled market situation implies business will no longer be carried out “as usual”. The environment is becoming relatively more transparent and strongly connected where market leadership becomes trickier. At least three points signal the ways in which banking business is being transformed: technology; regulatory frameworks; individual attitudes and behaviours. Each reflects a deep change in how people bank and the way banking is changing in the market.

For many years, controlling customers was the main issue for most industries, including banking.[1] Control has been the essence of management because we are trained to measure inputs, throughputs, and outputs, and to look for increasing efficiency to produce desired results. This made sense during the Industrial Age, and when banks developed products and sold them to customers through a pipeline business model. This situation existed in the past and was possible only because of a lack of choice in the market. Effectively, banks have started losing “control” of customer relationships, because banking is increasingly being carried out through different touchpoints, and financial services providers. Self-banking is making customers less and less attached to the branch and its personnel while changing the paradigm of banking from a place, to something people do (King, 2012). Concomitantly, banks, needing to improve cost efficiency, started closing branches. More recently, banks are also transforming their core banking systems to make them more malleable and resilient to a fluid environment. This means moving from silos to cloud for some operations.

In transitioning to new banking, and without intention, banks have created a “disloyalty programme” that actively encourages customers to go elsewhere for banking services unless banks could make a true difference in the market by selling a true fair value to customers. While new competitors have entered with greater choice and degrees of customization and personalization, banks are becoming smaller relative to financial markets and to the size of many shadow banks.

[1] According to the Oxford Dictionary, the term ‘control’ as a noun means “the power to influence or direct people’s behaviour or the course of events”. The verb “control” can mean “to determine the behaviour or supervise the running of, maintain influence, or authority over someone or something”.

Technology and regulation are localizing knowledge that can be shared among and across various networks for the benefit of network members, to gain economies of scale in a wider, more open arena. Networks rely not only on the information technology side of society; they are nurtured by "social" networks, links of groups, and related information on consumer attitudes and behaviours, which are highly relevant when volumes need to be made and the network must sell something.

The more touchpoints in the market delivering banking services, the more the idea of platformization in banking takes hold. Platforms have been defined in various contexts, but one that has emerged and is more relevant in this context, considers a platform as a collection of products or services, which generates value by bringing different parties together and enabling interaction between groups of participants. In short, platforms are business models that create value by facilitating exchanges and by bringing together large numbers of participants (consumers and producers) with the goal of becoming a one-stop shop and developing onto an ecosystem of collaboration—while essentially acting as a core intermediary between parties and managing user participation and volumes of interactions. In all this, banking and some related services (such as payment, consumer lending, time and money deposits, etc.) are becoming the glue to facilitate exchanges in the real economy. Now, the big challenge is to retain participants. This requires developing network effects from managing services, information, and interactions differently from the past. The more users there are on the network, the more content and the more valuable the platform is in reaching and developing more customized and personalized services. This is because platform strategy aims to build or integrate an ecosystem with customers, partners, and services to promote creation and exchange of services so everyone can capture value under different forms.

These new realities of platformization show an impressive innovation rate along with the industries they belong to. Gawer (2009, p. 3) notes *(…) the emerging phenomenon of platforms affects industrial dynamics, creates new forms of competition, and reveals new forms of collaborative innovation across firms*. The understanding of platforms in services should be treated differently from an industrial approach. In fact, marketing and service research are the only fields to date that have linked platforms explicitly to the facilitation of value-creating interactions among economic actors. Smedlund and Faghankhani (2015) perceive platforms to be both the means and ends of value creation. Despite consensus that platforms are important, it is interesting to consider Breidbach and Hollebeek (2014) who integrate existing approaches in marketing and service research, and emphasize the crucial role of platforms in facilitating interaction, value co-creation, and engagement among actors in service ecosystems. We agree with Breidbach and Hollebeek (2014, p. 596) who define engagement platforms as *(…) physical or virtual touch points designed to provide structural support for the exchange and integration of resources, and thereby co-creation of value, between actors in a service system.* The concept of engagement platforms, therefore, represents a basic artefact and perspective needed to advance our understanding of the retail banking of tomorrow. As from the above comes a next big issue which is that of becoming aware, and reacting consequentially, that creating and/or co-creating value is a different game from extracting value within the "new normal".

The critical issue on platforms is that the economics are changing. Leaders of pipeline enterprises have long focused on a narrow set of metrics that capture the health of their businesses. For example, pipelines grow by optimizing processes and opening bottlenecks, and push enough services through and get margins high enough, so to get a reasonable rate of return. If focus changes from pipelines to platforms, then the numbers to watch change. Monitoring and boosting the performance of core interactions becomes critical (such as, interaction failures, engagement, match quality, other criticisms like congestion caused by unconstrained network growth which can discourage customers to get involved in the platform).

Platforms have existed for years. Malls link consumers and merchants; newspapers connect subscribers and advertisers. What is changing in this century is that information technology has profoundly reduced the need to own physical infrastructures and assets. IT makes building and scaling up platforms vastly simpler and cheaper, allows nearly frictionless participation that strengthens network effects, and enhances the ability to capture, analyse, and exchange huge amounts of data that increase the platform's value to all.

A platform model can represent an opportunity to enrich the customer experience, secure better cross-selling opportunities, and other external monetization revenue streams. But most importantly, it seems to be, at present, the "only" opportunity to retain customer relationships in tomorrow's world (Omarini, 2017, 2018).

The relevance of platforms, from conceptual and managerial perspectives, is explained by the fact that in future, customers are perceived to become more and more in control of their actions, and therefore of their money. This is true also for what they do with their banks or other financial partners because of the tremendous amount of different and innovative devices. That said, consumers are demonstrating increased willingness both to shop around and to purchase financial services and products from non-traditional providers as their preferences are changing rapidly. Mersch (2015) notes that *Retail customers now expect to be able to integrate e-commerce, social media and retail payments. They also expect to be able to switch seamlessly across digital platforms. These are not areas of strength for many banks; given their heavier compliance obligations, banks have traditionally invested more in security and resilience of their systems rather than optimizing the user experience.*

It is clear this is the time for banks to transform themselves digitally, explore new strategies, and undertake innovative business models. According to different consultancy approaches, banks can cover different roles in this business framework (Capgemini, 2019, 2020), such as integrator, supplier, orchestrator, or aggregator. The roles can be combined in the bank's overall strategy depending on the business use case, goals, and technical capacity. However, in order to adapt and move to such new approaches, banks need to move from their proprietary, internal focused architecture (pipeline model) to an external focused and more open-sourced one with different degrees of openness accordingly and consistent with its different business units (deposits, consumer lending, payments, insurance, etc.) (Van Alstyne Marshall et al., 2016). However, this also threatens banks with new risks and capital requirements.

9.2.1 Why is This Happening Now?

There are many answers to this question. However, it is useful to outline that while the core objectives of most financial intermediation have remained the same, the methods and functionalities relating to those objectives have changed because of digital technologies, market developments, and regulatory moves to instil a more competitive financial services marketplace. At present, data analytics is frequently the preferred method of choice, and automated online computer programmes are the favoured functionalities of choice. Automated, algorithmic computer programmes are now at the forefront of financial innovation.

All this comes after a long period where retail banking was perceived by customers to be commoditized because of weak differentiating value propositions, and where the price was the major influence upon choice (Omarini, 2015). Under these circumstances, the value produced, delivered and the value perceived were different and distant from customer expectations. In practice, the financial crisis turned banks towards their recovery while losing a bit of their ear for the market.

In fact, following the financial crisis, financial institutions faced increased regulation, falling profitability, and the need to update their risk management systems to keep pace with faster and more complex market conditions. Thus, banks focused on complying with numerous new rules, regulatory requirements, fines imposed, and the need to recover profitability. At the same time, the overall performance of banks has become increasingly subject to external market tests of efficiency at all levels and banks have increasingly adapted to a more stakeholder value-oriented culture. As a result, banks had to become more productively efficient (reducing cost/income ratios is one dimension of this productive efficiency trend) and more risk and return efficient (ensuring internal capital resources are allocated to achieve maximum return for each quantum of underlying risk).

This was when FinTech and BigTech firms started entering the market, thanks to a kind of deregulation, digital technologies, and a changing competitive force driven by the introduction of an ongoing evolution of a consistent customer experience across the entire financial institution which is paramount for creating digital growth.

The birth and rise of FinTechs are deeply rooted in the financial crisis, and the erosion of trust is generated. People's anger at the banking system was the perfect breeding ground for financial innovation. Good timing, because digital natives (such as the Millennials) were becoming old enough to be potential customers and their preferences pointed to the mobile services they understood and mastered, instead of bankers who could not relate to them.

Consumer habits have changed and not just for financial services. People have become accustomed to the interpretive ability of social media and Amazon to give them what they want to see, hear or buy. The next step for banking products and services might seem to be an algorithm-driven, impersonal experience but not for all the financial services, where the human touch is still of paramount importance, such as financial advisory. However, there will be financial services that will find growth through digital channels by doubling down on human connections, not the other way around.

Any further steps into the era of e-finance will make the circuit process look increasingly sophisticated and, in the meantime, it reaffirms the virtuality of bank money—based on the promised issued by specialized entities—and will always call on banks to give money a real content and preserve it, if banks can undertake this challenge.

These are the roots of the open banking paradigm, where money, production, and investment must be considered in an integrated way, where banking and finance interrelate differently in the course of economic development, however performing complementary functions essential to the economy, leading to different efficiency/stability configurations which are the next challenges for regulators and authorities to foresee and discern (Omarini, 2019).

Taking all the above into account, the banking sector has undergone an unprecedented change which has altered both the structure of the sector and the nature of competition within it. It is not surprising that over this time, financial institutions (particularly traditional ones) have had to adapt to remain competitive. The main challenges for banks include: creating a new operating model; creating a better online experience; transforming the retail network; trying to reduce complexity in terms of legacy burden and changing product mix and characteristics in an effort to keep to a minimum the risk-weighted-assets (RWA). However, everything starts from considering that in every strategy the ultimate objective is to do what the market needs. Future opportunities for any financial service provider lie exactly in the needs of their customers.

The new banking service providers have been developing non-conventional business models that compete on several dimensions though currently at the level of customer user experience. Thus, new entrants are aiding the transformation of banking business in dramatic ways. Generally, they target specific segments of financial institutions' value chains, aiming to provide services and solutions to loosen the bond between banks and their clients. In doing so, they are looking for and leveraging relationships with customers by developing their business models based on the following main characteristics: simplicity, transparency, ease of customer acquisition, ease of distribution and commercial attractiveness, and specialization. However, their role and position in the market have been evolving to become an enabler to something else by developing more customization and personalization in value propositions.

All the above is due to technology which is the most impactful element in competition within banking. Technology has lowered the cost of information production and is also a ubiquitous network so that producers can market directly to end consumers. Technology also lowers coordination costs, which implies an unbundling of functions, making it easier and more efficient to buy value chain functions rather than to make them in-house. The latter situation lets producers outsource some intermediary functions. Hence, the system increases reliance on third-party providers acting as outsources for many activities (both core and others).

9.2.2 The Role of Regulators and Authorities

The new technologies applied to the financial sector have attracted attention from a legislator's viewpoint. The most significant is the effort to provide a regulatory framework for Financial Technology in the European Union via the Payment Services Directive 2 (PSD2). This piece of regulation, adopted in 2015 and enforced from 13 January 2018, drastically aims to revolutionize the EU payments landscape and, as a result, the banking industry.

PSD2 is a key contributing factor in shaping and changing the banking industry and its value chain in Europe. The new directive encompasses several goals at different levels, including: the harmonization of payment services in the EU; applying common standards; enhancing transparency; incentivizing new players to introduce innovative services to enter the market; enhancing security standards; increase competition and improve and enlarge choice to benefit consumers.

In addition to compliance in security standards, and protection of consumers, the centrepiece of the regulation is the obligation to provide third parties, if the customer authorizes, with access to the data and information of the payment account the customer holds within a bank. This, as intended by the European Commission, would put consumers at the very centre of the landscape, where they could freely choose among a wide array of services from different providers, as banks are mandated to open information and interact with all other players.

Competition Policy Commissioner Margrethe Vestager stressed that PSD2 approval provides (European Commission, 2015): *"A legislative framework to facilitate the entry of (such) new players and ensure they provide secure and efficient payment services. [...] making it easier to shop online and enabling new services to enter the market to manage (their)* *bank accounts, for example to keep track of (their) spending on different accounts"*. Cortet et al. (2016) suggest PSD2 goes a step beyond a regulatory scope. PSD2 is an impressive accelerator of the digitization process that had already started to appear within banking. The regulation is having a severe impact on revenue streams considered as sticky by banks.

Among established providers, the directive frames new service providers into the following categories: (1) Payment Service Providers (PSP): Institutions authorized to provide payment services; and (2) Account Servicing Payment Service Providers (ASPSP): namely, banks within which users hold their accounts. In addition, PSD2 requires banks to enable customers to authorize licensed third parties to access their transaction history. Now banks are mandated to be able to provide "access to account" and communicate to authorized third parties, customers, and payment account information. This allows new players to thrive not only in the payments segment, but in other segments as well once they are able to tap into account information (Cortet et al., 2016).

Another major innovation of PSD2 is to allow third parties authorized by the customer, for example merchants, to initiate a payment directly from the customer's bank account to another party through the use of dedicated interfaces such as application programming interfaces (APIs)—bypassing the need for a credit card transaction—and so using direct channels into the bank. Open APIs enable banks to connect with their customers in different ways and connect with new styles of players to offer more personalized and customized services. APIs are the interfaces between software applications within an organization, and between one organization and another using a standard set of requirements, which make the interface easy to use and possible to protect quality.

PSD2 is a further regulatory response to changes in consumer behaviour and technological changes; however, it goes well beyond those changes. In fact, the directive aims to foster ulterior transformation through the prescription of a higher level of openness. In turn, this will accelerate an only apparent fragmented banking value chain, as consumers become free to choose services provided by third parties on the basis constituted by the (open) account that they hold at a bank. In this case, banks are not the only channel through which consumers will be able to access related services, thus separating a rather sticky account service relationship from the related services that banks could sell through that (once) preferential gate. The power of gateways is the critical point to monitor in future; it is where every customer's interactions begin.

All these premises substantiate the argument of interdependence between firms and modularity of services within the banking industry and outside, leading to the peculiar definition of "business ecosystem".

The European Union introduced another important piece of regulation useful to the implementation and reinforcement of the PSD2, which is the General Data Protection Regulation (GDPR). This regulation has been in force since 25 May 2018. In the EU, GDPR and PSD2 are both developing a regulatory approach to establishing a foundation for open banking. The launch of Regulatory Technical Standards (RTS) is another fundamental piece of the puzzle to achieving the objective of PSD2 to enhance consumer protection, promote innovation, and improve the security of payment services across the European Union.

All the above will pave the way for a broader set of firms to leverage and monetize customers' information. To synthesize, the new paradigm of banking sees banking becoming a modular and flexible enabler of different activities, aiming at satisfying more diverse customers' needs, habits, and demographics. In fact, open banking relates to open innovation (Chesbrough, 2003, 2011) to the extent that not only banks but anyone interested in using banking may rely on the flow of ideas from inside and outside its industry to develop products and services, and innovative processes. The move to open banking is spreading globally. However, the final impact will depend on the regulatory environment. Some countries, such as, the UK and Australia are already on the verge of a further step, which is the open finance framework where data sharing goes beyond transactions.

9.2.3 New Frameworks for Financial Services and Evolving Stages of Value Chains

The new banking will emerge with richer ecosystems where the deep de-integration of financial solutions to increase customer loyalty will find its way throughout the embedded and contextual banking. They will be major transformative trends though not completely new to the market. In fact, we can go back to old times when for buying a car you could have asked for a loan to that merchant. However, the new comes from the digitalization process that has developed an array of different use cases boosted by API technology.

The success comes from new value propositions that can leverage on rich business ecosystems. The next step for embedded banking is a phase of tech-enabled mass adoption of Banking-as-a Service, which means that more big brands will enter the market and take market shares away from incumbent banks, and neobanks. They will combine data through Artificial Intelligence (AI) and Machine Learning (ML), and will extend their reach by developing very customized services and products. Banking and financial services will boost their core business, in a first stage. In contrast, given today's banking technology, financial institutions could react and learn from consumers' pain points to give more effective answers to them by combining data and deliver consumer engagement centred services on big financial milestones. Delivering relevant and more helpful recommendations is mandatory for everybody willing to build a significant trust which remains the big issue for the future.

Technology is autonomous and strategically important. Often its source array is outside the tradition of the banking profession, which brings an exogenous culture into the bank. Technically speaking and from a PSD2 setting, a new series of ecosystem actors may emerge that are interdependent. The offerings and roles these actors are going to take to the market are thus modular and dependent on other complements along different value chains. The new on-coming business ecosystems will show and experience many shifts among businesses not yet connected.

9.2.4 *Nascent Business Ecosystems in a Nutshell*

Our discussions mean we can synthesize that the market is going to experience different forms of banking: on one hand, there is the old banking renewed in different shapes, and on the other hand, there is the new banking, rooted in digital technologies and triggered by new regulatory frameworks. On top of that there are the BigTech giants already in the market providing their customers with some financial services.

This implies that there are some traditional banks that have outsourced the tech department;, for them, tech is usually driven by a more captive service provider. They show limited capabilities to innovate rapidly and react to market requests due to legacy systems. They also have very often little mandate to surf the third party's providers. On the other hand, there are very innovative customer-centric tech-driven ecosystems, which are interested in integrating financial solutions, but lack experience in regulation, have no banking license, compliance nor banking processes. For these companies, the need is to build platforms to solve these issues, as Banking-as-a-Service provider[2] (such as pure BaaS companies—SolarisBank, Bankable, Treezor, 11:FS Foundry, ClearBank—, and BaaS companies with retail banking services, such as Starling Bank, Fidor Bank, Green Dot, BBVA) to make them integrating banking services into their business.

9.3 Challenging Regulators to Balance Innovation, Stability, and Customer Trust

The task to balance innovation, stability, and trust is a difficult one. There are many different actions to undertake: from putting a bar on new entrants to increasing regulation on new activities while keeping Open Banking and Open Finance on going to improve competition in the market. However, it must be also recognized that as the digital economy has matured, a small number of firms have become the largest and most influential, often connecting together multiple platform businesses into powerful ecosystems and emerging as "gatekeepers" through which almost all participants in the digital economy need to pass.

Therefore, the future will comprise different degrees of banking (from conventional banking delivered throughout incumbents and their related digital transformation, to new players both FinTechs and BigTechs).

The situation will be partially a kind of a learning curve experience. For instance, the recent example of the Australian Prudential Regulatory Authority's action to impose stricter conditions on applicants for deposit-taking licenses is following the recent collapse of digital challenger Xinja. A review undertaken into Australia's licensing regime found the approach needed greater focus on longer term sustainability, rather than the short-term ambition of receiving a license. Under the new guidelines, restricted Authorised Deposit-Taking institutions (ADIs) must achieve a limited launch of both an income-generating asset product and a deposit product before being granted a full license. There is also increased clarity around capital requirements at different stages for new entrants, who will also be expected to have more advanced planning for a potential exit, including a focus on return of deposits as an option. This approach is looking to ensure that newly licensed banks are better equipped to succeed.

[2] https://www.businessinsider.com/banking-as-a-service-platform-providers?IR=T.

In the UK, the Financial Conduct Authority (FCA) is using its legislative powers to steer the evolution of the Open Banking framework to a broader model of Open Finance. This refers to the extension of Open Banking like data sharing to a wider range of financial products, such as savings, investments, pensions, and insurance. The FCA perceives that this could potentially offer significant benefits to consumers, including increased competition, improved advice, and improved access to a wider and more innovative range of financial products and services. However, the same regulator believes it would also create or increase risks and raise new questions around data ethics and digital identity. This requires, on the one hand, an appropriate legislative and regulatory framework, as the FCA states, that will be essential to managing risks and giving consumers the confidence to use Open Finance services. On the other hand, common standards and an implementation entity are needed to give consumers greater control of their data.

Moving onto BigTechs and platform business models, there are interesting opinions, such as the one of Edward Corcoran[3] from BBVA's Digital Regulation team that states that three things are needed. *First, the right scope, ensuring that all large platforms which can dictate conditions in digital markets are covered. New rules should apply to both online platforms, like marketplaces and social or communication networks, and the hardware and software through which end-users' access all of those services, in the form of a mobile device and operating system. Second, straightforward rules need to apply from the outset to address the key issues of access to digital infrastructure and users' control over their data. Providers of digital infrastructure, such as smartphones, should have to ensure that all functionality is available to all developers on equal terms. And platforms should offer all users portability of their data, so that they can easily and safely move it whenever they wish, reducing data lock-in effects and helping to drive innovation through the reuse of data. Third, given that digital platforms typically extend across borders, the supervision and enforcement of new rules needs to be coordinated, avoiding fragmentation in approaches across EU member states.*

The EU has been at the forefront of the debate on the implications of the growth of the digital economy and its importance to firms and consumers alike. It now has the opportunity to introduce new rules that

[3] https://www.bbva.com/en/opinion/new-regulation-to-meet-the-challenges-of-the-platform-economy/.

ensure markets remain fair and create opportunities for all participants to thrive. *In addition, policymakers have recognised that by accelerating structural changes and amplifying existing risks related to BigTech's inroads into financial services, open banking could have a detrimental impact on financial stability*.

Another interesting perspective on the same point comes from Daniel Sokol and Van Alstyne (2020). They suggest *that unless platform companies act now, regulation could erode the powerful network effects that drive their growth and benefit their users*. This is because, in October 2020, the U.S. House Judiciary Committee's antitrust subcommittee released a report following an inquiry into digital economy.[4] The many sentiments around platforms are producing new rules and laws, expanded powers for existing regulatory authorities, and the establishment of new regulatory authorities. The authors affirm *these outcomes will not only affect Big Tech but also many other companies, in industries such as construction, health care, finance, energy, and industrial manufacturing, that have adopted or are considering adopting platform business models*. *Few platform operators and owners have fully considered how the growing regulatory risk—which includes breakups, line-of-business restrictions, acquisition limits, and interoperability and data portability mandates—could derail their businesses*. It is recognizable that the regulatory outcomes, such as a structural breakup could have varying degrees of impact on platform businesses and this could unravel the network effects that drive platforms growth and produce value.

Our discussion implies that the issue, which is going to be a big challenge, is how to communicate and educate customers in becoming more aware of the changes the market is undertaking. This is because a customer might find himself/herself in a one-stop financial hub. On this issue, the European Commission (DG FISMA) and the OECD International Network on Financial Education (INFE) will jointly develop a financial competence scheme for the European Union. The project is developed in the framework of the EU Capital Markets Union (CMU)

[4] The report recommended fundamental changes to antitrust laws generally and targeted the Amazon, Apple, Facebook, and Google technology platforms specifically. Several weeks later, the U.S. Department of Justice filed suit against Google, accusing it of using "anti-competitive tactics to maintain and extend its monopolies in the markets for general search services, search advertising and general search text advertising". Similar regulatory initiatives aimed at platforms are underway around the world, including in the EC, UK, Japan, Korea, and India (Daniel Sokol & Van Alstyne, 2020).

Action Plan, which mandates the European Commission to work towards the development of a dedicated EU financial competence framework. It will reflect recent and emerging issues, including financial digitalization and sustainable finance. The new EU scheme will aim at providing a common terminology and framework at the EU level for informing the development of financial literacy policies and programmes, identifying gaps in provision, and creating assessment, measurement, and evaluation tools.

Hence, it is not an oversimplification to suggest that the issue of financial innovation, fuelled by technology, and consumer protection is mostly about access and suitability. Access refers to a situation in which affordable, mainstream financial products are available to all segments of the population across the range of income levels and demographic characteristics. Suitability addresses the appropriateness of products for particular consumer groups. All the above requires to answer some of the following questions: which products may safely be sold to retail financial consumers? By whom? Who decides? And who holds the liability should something go wrong?

This seems to be the future need for regulatory response that is happening at different speeds globally. The next few years will shape the future of financial technology. This is an ongoing process, however, and while there is a strong commitment from regulators to drive innovation, there are still certain regulatory challenges to the immediate uptake of new technologies in the banking industry. The result, at present, is that technology and regulation closely interact. As technology alters financial service attributes and market structure, financial regulation must adapt to remain effective. In turn, regulation exerts an important influence on the development of technology. Neither technology nor regulation is exogenous.

9.4 Conclusions

The application of modern technological advancements to financial products and services has challenged the traditional financial industry to provide better financial solutions to their clients. Many competitive boundaries have started to loosen due to deregulation, and some lines of demarcation have been eroded meaning banks have found themselves facing massive competition in many of their business areas. Equally the FinTech phenomenon has increased pressures by allowing non-financial businesses to provide tailored digitalized financial solutions. Furthermore, the traditional workflow of the financial industry is currently being disrupted implying that the banking process is moving from an isolated silo approach to an Open Banking and Open Finance approaches. The traditional banking business model is being questioned as new ways of innovation and cooperation are arising in ways that are altering the conceptualization of conventional banking business models.

While it is too early to judge the future of the banking landscape, the near future is expected to witness a lot of teething pain with need for clarity on both regulatory and industry sides. Attention is required to see what is regulated, who is regulated, and how it is regulated. This is the case of learning to walk before you can run. While PSD2 is fundamentally an important catalyst to making everything happen, it is not the end in, and of itself.

PSD2 is a true game changer because banks will no longer only be competing against other banks, but all firms offering financial services. However, most of the boost comes from open APIs that can take current account data and let software developers create new products that use and combine data in new ways. A simple example would be an app that collects an individual's financial information together from several sources—several different bank accounts, for instance, and allow that individual to manage their financial affairs from one app on their phone. The ability to access data on multiple bank accounts might not seem immediately game-changing. However, the thought behind Open Banking, and moreover, Open Finance, is that start-ups will use those data and leverage their potential by developing innovative new services that no one has yet thought of.

In the new framework, where customers are in control of their data, it is fundamental to consider consumer protection specifically to ensure customer trust in the market. If we consider financial innovation in the context of consumer protection, it can be said that innovations do not necessarily create new problems, but they have a tendency to aggravate the existing challenges of asymmetric information, market power imbalances, and other imperfections which characterize markets in retail financial products (Lumpkin, 2010).

Trust is required between all entities involved in a transaction and towards the asset being transferred. A lack of trust in financial intermediaries, processes, and in anyone managing financial data can hamper the functioning of financial markets. Technological changes will not eliminate the need for trust but it may induce market participants to look for it elsewhere and beyond traditional intermediaries like banks. In the future, networks and new service providers will need to find ways to gain the user's trust, and regulation will also have a critical role to play in this ongoing process.

It is important to ensure that consumers are better able to make informed choices and achieve fair deals. This is going to be the future challenge for every stakeholder in the ecosystem. Addressing product tying and ensuring responsible marketing practices (to avoid mis-selling) will be critical issues.

It is worth highlighting that some efforts are already underway to strengthen cross-border cooperation and harmonization. Bilaterally, some national regulators have established cooperative arrangements to promote innovation and share information about innovative financial services. At the multilateral level, international standard setters, such as the International Organization of Securities Commissions, the Basel Committee on Banking Supervision and the Committee on Payments and Market Infrastructures, as well as the Financial Stability Board, are all monitoring and studying the implications of technological change for financial stability, market integrity, efficiency, and investor protection, while others have already issued some guidance.

At the European level, the European Commission may propose either (1) a dedicated "Fintech directive/regulation", using an entity-based approach, or (2) additional activity-based directives/regulations. The latter would be consistent with the EU's traditional financial regulatory approach.

The ending of regulatory fragmentation might constitute an improvement, especially in customer due diligence/KYC (Know Your Customer rules). This will be an important step towards enhancing competitiveness as well as preventing differentiated treatment of competing downstream services by large, vertically integrated platforms, in order to strengthen innovation and maintain consumer choices. Another important pillar would be to establish a comprehensive cross-sectoral and consistent user data-sharing framework to promote innovation and competition, and create a level playing field among actors to foster competition.

It might not be too early to consider new regulations by starting to think about the desired end state: how would we like the sector to look in the future? Which organizational structures are most likely to deliver sustained and responsible innovation and, based on this desired end state, what regulatory approach seems most likely to facilitate and encourage such businesses?

What is apparent it is that incumbent providers cannot ignore the disruption they have had to face from an unprecedented combination of new pressures. Crucially, all this disruption involves digital technologies at some level. Partnering for innovation could be an effective option for incumbent financial service providers to develop and reinvigorate their services and learn from technology start-ups, especially when incumbents lack capacity for technology-driven innovation.

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CHAPTER 10

Bigger Fish to Fry: FinTech and the Digital Transformation of Financial Services

David McNulty and Alistair Milne

10.1 Introduction

This chapter is an essay on the economics of financial technology. It discusses the appropriate role of public policy in supporting the development and deployment of financial technology. The contributions it aims to make are: (i) to provide an overview of the current position of FinTech in the UK as a leading global centre for financial innovation, and the case recently made by the Kalifa Review for expanded public policy support for UK FinTech; (ii) a conceptual discussion of the justification for such public policy support. This highlights how financial technology can be employed to address the substantial market and organisational failures in financial markets and institutions, and therefore how public policy

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towards FinTech might more appropriately be seen in the broader context of supporting the digital transformation of financial services, not as a more narrowly focused support of FinTech start-ups. These arguments are then illustrated in relation to the specific challenges of insurance, and InsurTech, in the UK.

10.2 FinTech in the UK

Two recent publications—a July 2020 sectoral review conducted by EY on behalf of Innovate Finance and the City of London, and the February 2021 Kalifa Review of FinTech in the UK commissioned by UK Treasury—have together provided a useful snapshot of FinTech in the UK, and the policy initiatives used to support it (Kalifa, 2021; Kimber et al., 2020). The UK is a leader in financial technology; UK FinTech firms—across its various subcategories such as PayTech, CrediTech, InsurTech, WealthTech, RegTech, and other applications of financial technology—achieved revenues of £11bn in 2019, and investment of £3.6bn. EY estimate that FinTech firms account for around 8% of the £132bn UK financial services output, and that 1600 UK FinTechs account for 76,500 of the 1.1 million employees in UK financial services. Only the US, with 2019 venture capital investment of around $13.6bn, and China, with their large online market and underdeveloped traditional financial services sector allowing the rapid development of giant FinTechs such as Ant Financial and Ping An Insurance, have clearly larger FinTech sectors.

The UK has also been a pioneer in policy initiatives to support financial technology. In 2014, the UK Financial Services Authority (since replaced by the Financial Conduct Authority) launched its 'project innovate' to support financial innovation. This is described in the subsequent five-year review (FCA, 2019). The programme involved some 686 firms in its first five years, offering valuable guidance to help start-up firms through the process of regulatory authorisation. 110 firms were accepted for five cohorts of its 'regulatory sandbox' (and a further 22 firms for the sixth cohort, with a December 2020 deadline for seventh cohort applications). The sandbox allows start-up firms to access regulatory expertise and to operate under a tailored authorisation regime, restricted to testing certain ideas agreed for the sandbox activity. The sandbox concept has been described as being '…established to allow innovative FinTech businesses to navigate the regulatory requirements by "testing" their business concepts without having to comply with certain financial regulations. The sandboxes established thus far have included licensing exemptions and conditional relief from regulatory requirements such as the need to obtain a financial services licence. While operating in the sandbox, businesses can conduct certain transactions and services within defined threshold limits, which allows them to innovate while protecting consumers and the integrity of the financial system' (Bromberg et al., 2017). The FCA has also brought finance and technology practitioners together by organising a series of 'tech sprints', with the aim of developing new financial solutions. These have aimed to support development both in 'roboadvice', which has the goal of making personalised financial advice affordable to consumers that may have been unable to afford the charges associated with a traditional personal service, and in 'RegTech', which aims to mitigate the potentially significant costs associated with regulatory compliance.

This regulatory support for financial innovation has spread globally. The World Bank reports that by late 2020 there were 73 regulatory sandboxes, set up across 57 jurisdictions (Appaya et al., 2020). The FCA has also been involved in the creation of a global financial innovation network, with sixty regulatory organisations from twenty-nine jurisdictions exchanging knowledge on the regulation of financial innovation, and supporting an environment in which firms can test cross-border solutions in a controlled regulatory environment (FCA, 2021). These initiatives appear to have been successful in promoting early stage innovation in financial technology (Goo & Heo, 2020).

In parallel to this, the UK has also promoted the development of crowd-based funding, especially crowd-based lending (also referred to as 'peer-to-peer' or 'marketplace' lending), with a tailored and relatively permissive regulatory regime during the period 2014–2016, and tax support through the so-called 'innovative finance ISA' introduced by then-chancellor George Osborne (Chen et al., 2021). There has, however, been a subsequent tightening of UK regulation of loan-based crowdfunding with an increased emphasis on investor protection, in part a response to the 2019 failure of the loan-based crowd-funding platform Lendy.

Further development in the UK has been the mandatory regime of open banking, developed by the Competition and Markets Authority to remedy the lack of competition in personal current account and small business banking (Competition & Markets Authority, 2016). This has been a substantial initiative, requiring the nine largest banks in the UK to co-operate on developing standardised API ('application programming interfaces') supporting the permissioned and limited sharing by customers of their banking data with third parties. This is a much more secure technology than was previously possible, where customers would have to share passwords to allow 'screen scraping' of internet banking apps. A consequence of this initiative has been the development of an active 'ecosystem' of providers seeking to offer banking, credit, and wealth management solutions that utilise this shared access (The Open Data Institute & Fingleton, 2019). By January 2020, the Open Banking Implementation Entity was to report a million users of open banking-based applications, served by over 200 active service providers (Open Banking, 2020).

Further prominent development in UK FinTech has been the rise of online-only 'challenger' banks, that seek to attract customers from the major high street incumbents that have dominated UK banking for decades (*The Economist*, 2019). While the UK banking regulator (the Prudential Regulatory Authority) has awarded a number of new banking licenses to digital-only banks including Starling, Monzo, and Atom, and these banks have attracted many new account openings, many have been for 'second' accounts, not the transfer of primary banking services (FCA, 2018). Some digital-only banks are also struggling to achieve sufficient scale to convert account openings into sustainable profits, with the COVID-19 pandemic putting them under additional financial pressure. The PRA has further expressed concerns about the need for some new and growing banks to strengthen their governance and invest more in risk management and controls (PRA, 2020).

Other areas of financial innovation attracting attention are more specifically technology-focused. One such example, fuelled by the rising prices of cryptocurrencies such as Bitcoin, can be observed in blockchain and distributed ledger technologies, and their potential for supporting a disruption of conventional financial intermediation through an alternative decentralised financial architecture based on the exchange of crypto-assets. Another is the employment of artificial intelligence such as machine learning and natural language processing in finance. While UK start-ups are active in blockchain, cryptocurrency, and artificial intelligence technologies, this still represents a relatively small share of FinTech activity, accounting for only 10% of the 224 respondents to the EY survey of UK FinTechs (Kimber et al., 2020, Figure 2.5).

Overall, FinTech in the UK is an undoubted success. The Kalifa Review makes a case for building on this success with further public sector support. This proposes, along with a package of non-financial measures such as the creation of a Centre for Finance, Innovation and Technology, some specific supportive actions: (i) the development of a 'scalebox' (now being implemented following an announcement by HM Treasury (2021), a follow on from the FCA regulatory sandbox, 'introducing measures to support partnering between incumbents and FinTech and RegTech firms, and providing additional support for regulated firms in the growth phase'; (ii) measures to support the availability of skilled talent through both training and a visa stream for FinTech start-ups; and (iii) an expansion of R&D tax credits available in the current Enterprise Investment Scheme and Venture Capital Trust that support UK venture capital funding, alongside a £1bn FinTech growth fund. The 'vision' of the Kalifa Review is that continuing supportive policy can support the competitiveness of London as a financial centre post-Brexit and enhance the growth of FinTech clusters around the UK, playing a major role in the 'levelling up' of disadvantaged regions and the creation of high skilled employment opportunities around the country.

10.3 Financial Innovation Policy: A Conceptual Framework

The case made in the Kalifa Review for further public sector support for innovation in financial technologies is attractive, but perhaps only superficially so. There are many other compelling, competing claims on public sector resources, and the attention of policymakers. It might just as well be argued that the very success of UK FinTech indicates that it has now moved beyond early stage growth requiring public policy intervention and can in the future stand on its own feet, continuing to expand without the need for continued policy support.

This section presents a conceptual framework that can be employed to assess policy for supporting innovation in financial technology, in the UK and other jurisdictions.

First, some general considerations:

- FinTech is not an industrial sector meriting its own SIC or listed equity subindex classifications. FinTech—and the active start-up 'ecosystem' engaged in FinTech innovation—is part of the broader digital transformation of financial services. Just as other sectors such as telecommunications and recorded media have previously undergone transformative technology-driven change, so now financial services are also being transformed by the adoption of digital technologies. This change is not entirely start-up driven: much innovation is also adopted by existing firms; working with start-ups, making their own in-house innovations, or adopting technology provided by major information technology firms. This illustrates that FinTech start-ups are only one part of this larger picture.

- The landscape of FinTech start-ups will evolve over time. As the technologies mature the importance of start-ups can be expected to diminish, with attention shifting to the adoption of technology in the mainstream and the successful scaling of growing firms, rather than first-stage innovation; and with successful new entrants no longer so clearly distinguishable from incumbents. A likely eventual outcome is that the supply of venture capital funding for FinTech will slow, and the rate of establishment of new FinTech start-ups will diminish; this is likely to be followed by a period of consolidation, with some FinTechs absorbed by existing firms, others establishing themselves as niche providers, with the remainder unable to sustain their activities and winding down as they lose access to venture capital funding. The prospects for FinTech as an investment asset class are therefore very different from the prospects for some other areas of technology, biotech for example. In the case of biotech, the rate of start-ups and supply of venture capital can be expected to continue undiminished, with the continuing advance of medical and pharmaceutical science and the increasing demand for innovation with ageing demographics.
- This likely eventual slowing in the rate of FinTech start-ups does not mean there will be no transformative technology-based change in financial services, or that traditional incumbent business models will triumph over the threat posed to them by challenger institutions. Technology innovation could, for example, support an evolution from closed, institution-based end-to-end provision, towards an open, platform-based value chain with choice and competition in each element of it, to the benefit of clients and consumers. Policy for financial technology should therefore focus on the final outcome, and on ensuring that it adequately serves the interests of end users, relative to those of the providers of financial services.

- All of this implies that policy towards financial technology needs to be framed in a broader context: that of supporting the wider digital transformation of financial services that would reduce costs, improve efficiency, and in particular, address the underlying frictions that have limited access and raised charges for consumers. Historically, as pointed out by Thomas Philippon, financial services have been characterised by unjustifiably large margins (Philippon, 2016). There are also widespread concerns over the excessive financialisation of the economy, drawing resources and skills away from other productive uses (for example, Foroohar, 2016). Technology can and should assist in achieving a rebalancing of the margins and activities in financial services compared to other economic activities.

Turning to the question of the appropriate public policy towards the role of financial technology in the digital transformation of financial services, two concepts are central; those of (i) market failure; and (ii) organisational effectiveness and governance. The remainder of this section discusses these in turn.

1. Market failure is a standard economic policy concern, addressed extensively in textbooks. Economic policy intervention is justified if it realises gains from trade or from investment that are not achieved from the spending and investment decisions otherwise taken by firms and households. These interventions could be direct tax and spend interventions to reallocate resources, or indirect interventions to change market arrangements and the information available for private decision-making. Standard examples are interventions to reduce market power, and to provide public goods. The rationale for such interventions is easily stated, but these can be difficult to carry out in practice because there is no guarantee that interventions will realise the anticipated economic gains.

   Some market failures that block efficient innovation are in labour and capital markets, and not specific to financial services. Taking labour markets first, wage and salary differences only indirectly and ineffectively encourage investment in the required innovation skills. The mobility of a skilled workforce can discourage employers from investing in these skills themselves. These skills are also in the highest demand and paid most where there are high short-term returns to be captured by the employing firm. As a result, these same skills may not be employed to an efficient level, for example in activities with higher but riskier longer term payoffs, or where benefits accrue to a wider number of stakeholders. Higher education can respond to demand by providing relevant educational qualifications, but does so only slowly, and usually with a focus on the technical aspects of the technologies rather than their implementation in commercial situations.

These skills shortages could be addressed through the development of geographical centres of industrial expertise. When operating within an active, localised industry with an innovation focus, a firm may better perceive and internalise the benefits to the industry of their investment in skills. Competition for these skills, and the opportunity for career enhancement through moving between positions and acquiring further skills enhances the attractiveness of the sector to a skilled workforce, in turn supporting innovation. London as a global financial centre is an example, benefitting from the concentration of demand for financial services that has, in turn, created the demand for and investment in the required legal, financial, and operational skills.

Turning to capital markets, another widely recognised market failure affecting innovation across industries is in the supply of early stage financing for start-up firms. Venture capital technology investment in Silicon Valley is held up as an example, in contrast to almost anywhere else in the world, of how an industry can achieve rapid growth when constraints on the supply of funding are relaxed. The success of Silicon Valley venture capital investment is though, to an important degree, another example of geographical concentration overcoming market failure. Also, as the excesses of the 'dot-com' bubble of 1997–2001 illustrate, the prospect of realising returns in a strong equity market may lead to an excess supply of venture capital for technology-orientated investment. Still, an argument can be made for at least some public sector resourcing for earliest stage equity investment, and (because of related concerns about market failure in the supply of debt finance for small companies) also debt financing of innovative companies.

These considerations lead to the following conclusion. The recommendations of the Kalifa Review for supporting skills and capital investment are an appropriate response to these labour and capital market failures; but they should be applied across *all* sectors of the economy where similarly transformative opportunities are available, e.g. e-government, biotech, limited to finance.

There are several other well-known market failures specific to financial services. Information asymmetries and transaction costs can result in an inefficiently low provision of, for example, credit and insurance, particularly to smaller companies and lower income households which in extremis can result in financial exclusion (Demirgüç-Kunt & Klapper, 2013). Many financial services have an important element of shared provision, for example infrastructure for payments processing or the sharing of credit information, and as a result existing firms may have weak incentives to innovate on these shared provisions (Milne, 2006). Behavioural and informational problems can result in inappropriate advice, management, and outcomes for personal investment (Stracca, 2006), while risk management in financial firms does not internalise the systemic transmission of risk through markets (Haldane, 2014). Further financial market failures also arise as a consequence of public intervention to deal with market failures, notably the creation of 'moral hazard' that can result from the financial safety nets required to protect essential financial functions such as the retail payment system and the provision of the business credit for trade and working capital, and also prevent the materialisation of systemic financial crisis.

Our key point about these further market failures in financial services is that all of them, potentially and to some degree, can be mitigated using technology. Understanding this is critical in forming appropriate public policy towards financial technology. Seen from the broader perspective of the digital transformation, a key public policy issue is ensuring, through regulatory mandate where necessary, that *technology is used to reduce market failures in financial services*.

While this is sometimes a problem of the supply of technology solutions—for example, improved tools of risk assessment helping address insufficient supply of credit or insurance—more often the technology is already well developed. The problems are public good issues, such as developing and deploying agreed data and technology standards, establishing market-wide solutions for digital identity, and agreeing on the sharing of data, and of interoperability and access to financial platforms to reduce entry barriers and promote competition. A pioneering start has been made in the UK's Open Banking regime, but there is much more to be done in order to reap the benefits of digital technology in supporting fully open and transparent financial services.

2. Organisational effectiveness and governance is a further key challenge, internal to firms and hence all too easily passed over when focusing on market failure. It can be expressed using the well-established concept of x-inefficiency (Leibenstein, 1966). Management may fail to make full use of resources at their disposal, thereby achieving less than the potential output from the inputs employed in their businesses.

   Like market failure, this is a general concern, not one specific to financial services. But many regulatory and investment concerns in financial services are rooted in organisational failures. Two points can be made here:

   - First, that the size and complexity of large financial services firms can create barriers to modernising their own technology. A commonly asked question is why large established firms do not rapidly implement the same customer-friendly technologies that are used by new non-bank technology-based credit providers (Seru, 2020).
   - Second, the opaqueness of much financial services activity can exacerbate these problems of organisational control. This leads in turn to prudential concerns where management, instead of acting in the interests of shareholders as standard economic models assume, hide exposures in order to avoid failure. Many examples of such management failures, including at UBS and Merrill Lynch, emerged in the wake of the 2007-2008 global financial crisis (Milne, 2009). Other more recent examples also spring to mind. For example, the recent large-scale losses at Wirecard and at Greensill Capital might have been avoided if these firms had employed financial technology that would make their assets and exposures more transparent to investors (Chazan & Storbeck, 2021; Mavin & Steinberg, 2021). Ironically, both these firms promoted themselves as 'FinTech' companies, when in fact it appears they were not adequately

employing FinTech to support investor oversight of their own businesses.

Organisational failure is equally a concern in regulation, supervision, and policymaking. Sometimes individual supervisors and regulators may fail to take the actions necessary to avert prudential or conduct risks, as for example in the 1995 failure of Barings bank (Brown, 2005), while more general problems of forbearance and regulatory capture can undermine the effectiveness of financial regulation (Baker, 2010; Kane, 1987).

Discussion of organisational failure naturally brings in the question of governance, and its role in addressing both market failure and managerial effectiveness. The decisions of organisations, both financial services firms themselves and the regulatory and political institutions that oversee them, affect a range of stakeholders. Achieving appropriate outcomes therefore depends on effective governance that ensures these organisations are working effectively to achieve both individual and collective goals. This perspective is omitted from the Kalifa Review.

Policy towards FinTech needs, in short, to move beyond a somewhat oversimplified conception of the promotion of innovation in financial technology as a policy goal. Policy towards financial innovation should, crucially, be seen as part of the broader policy challenge of achieving a successful digital transformation of financial services; a transformation that can in turn help address the major problems of market failure and governance that are at the root of many of the major prudential, conduct and efficiency problems that are widespread across the industry.

10.4 The Example of UK InsurTech

This section uses the conceptual framework developed in the previous section to discuss appropriate policies for supporting financial technology in UK insurance. It draws on the findings of the TECHNGI research project carried out at Loughborough University (https://www.techngi.uk/).

InsurTechs are an active segment of UK financial technology, addressing both retail insurance and the needs of the London insurance market. One driver of InsurTech in London is its position as the leading global market for commercial and speciality insurance, with a leading role played by the Lloyd's Market. There are several London-based industry groups and conferences focused on InsurTech (e.g. https://InsurTechuk.org/, https://www.InsurTechinsights.com/, https://FinTech.global/globalInsurTechsummit/). Several major UK insurance groups support InsurTech hubs and accelerators including the Lloyd's Lab, supported by the Lloyd's Insurance market. Several InsurTechs (Cuvva, Laka, Blink) are highlighted in the FCA review of its regulatory sandbox (FCA, 2019). InsurTechs account for 4% of the UK-based FinTechs surveyed by EY (Kimber et al., 2020), but this figure somewhat understates their importance since many firms active in other categories, such as RegTech, digital identity, analytics, and big data are offering insurance-related technology solutions (Van-Meeteren et al., 2020, provide an overview). So broadly, the industry is already doing a capable job of promoting financial technology in UK insurance, without a clear need for specific public policy support. There are opportunities however, arising from both market and organisational failures, for public policy to usefully support the wider digital transformation of UK insurance.

10.4.1 Market Failures

The efficient provision of insurance, like other financial services, must overcome a range of contractual and other transaction costs (He et al., 2020, review the role of transaction costs in insurance and the development of insurance services). These transaction costs can for example inhibit or prevent the insurance of smaller 'micro' risks, where the contractual costs outweigh the benefits of cover.

Technology has a role to play in overcoming these costs—evidenced by the range of InsurTechs that are providing tailored micro-insurance solutions. Examples include: professional indemnity insurance for the 'gig' economy; short term, by-the-hour car insurance; the employment of parametric insurance to help farmers in low income and emerging markets manage weather-related risks (Hazell & Hess, 2017); and offering or exploiting new data from the internet of things, for example in telematics (Holland & John, 2021). These examples are not market failures requiring public policy intervention. Rather, the opposite is true: they indicate that market incentives are working. Start-ups are actively exploring the opportunities of applying new technologies to address insurance market failures. So, public policy support is not obviously required to directly support the development and adoption of new InsurTech innovations.

A separate market failure limits insurance of risks, for example those arising from natural hazards such as tropical storms or earthquakes, with large tails of potential loss. Uncertainty about the distribution of these tail risks limits the extent to which insurance exposures can be shared through reinsurance, and the transfer of risks onto global security markets. In theory, these risks, uncorrelated as they are with business cycle and stock market returns, should be an attractive part of a diversified investment portfolio. Here, there is a strong case for public policy intervention, but this is not a case for direct support of start-ups, rather a case for public sector encouragement and potentially, requirement for the sharing of data. This in turn can support more effective and efficient employment of technology in modelling, understanding, and management of these tail risks (Holland et al., 2021; Timms et al., 2021).

10.4.2 Organisational Failures and Governance

This section is completed with some examples from the work of our TECHNGI project, highlighting the role of technology in improving outcomes for the UK insurance industry. Opportunities include public policy support to overcome organisational failures, improving the governance of technology, and to promote a more complete digital financial transformation.

The insurance industry illustrates the organisational challenges of successfully adopting new technologies in large, diversified firms. The insurance value chain contains many elements: customer acquisition, risk assessment and pricing, underwriting and reinsurance, claims processing, regulatory and management reporting (Holland & Kavuri, 2021). Applying artificial intelligence and other automated data processing technologies to fully achieve potential business benefits is a major change project. This requires, first and foremost, developing an organisation-wide data strategy, with the collection, curation, and acquisition of data orientated towards achieving business outcomes; then, taking this forward to application through effective cooperation between domain experts and technologists, with the support from c-suite and coordination of change across the business (Herbert et al., 2020). In practice, the experience of many firms is that technology adoption has been relatively piecemeal; improving particular processes, but not yet amounting to digital transformation (Milne & Zarifis, 2021).

The importance of coordination for technology adoption is further illustrated by the Lloyd's Insurance Market. With its history dating back to seventeenth-century coffee houses, Lloyd's may not seem the most obvious pioneer of digital financial transformation. But in recent years, with a growing need to embrace new digital ways of working, this is exactly what it has become. With the shift to remote working required in response to the COVID-19 pandemic as a catalyst, Lloyd's has developed an ambitious programme of technology adoption: 'The Future of Lloyd's' (https://www.lloyds.com/about-lloyds/futureat-lloyds/). It illustrates the central role of collective governance, in technology adoption with the development of data standards and a shared data store, as the foundation for digital operations among the brokers and underwriting syndicates of the Lloyd's market (Milne & Steiger, 2021). The Lloyd's market is important, but it is far from being even the entire London insurance market. The wider public policy lessons here are about the benefits from encouraging similar cooperation between firms across the industry to take full advantage of the opportunities offered by technology.

A third example of the challenges of coordination is the interaction of start-up and incumbents in UK insurance (challenges which we hope the new FCA scale box initiative will address). The strength of London as a global centre of insurance expertise, and the availability of venture capital has led to an active ecosystem of start-ups, hubs, and accelerators exploring a wide range of technologies (Van-Meeteren et al., 2020). This activity is not primarily focused on disruption, or challenging the position of incumbents; instead, some 80% of InsurTech start-ups are focused on cooperation with incumbents, and on the incremental value gains available from modest adjustments to existing business models (Holland & Kavuri, 2021). What is not yet emerging from this innovation ecosystem is a more fundamental, transformative shift in business models. The public policy question here is whether intervention is appropriate to support more fundamental change.

Our fourth example is the application of regulatory technologies in insurance ('RegTech'). As in other regulated financial services, the costs of regulatory compliance are substantial, both in terms of direct costs to firms and customers, and also in acting as a barrier to entry that reduces competition. While these costs are not as high as in banking, they still amounted to more than 2% of revenues for UK insurance firms in 2014, and have risen further since (Milne et al., 2020).

Costs are not the only issue. From the broader perspective of the digital transformation of insurance, there are opportunities to use digital technologies to address concerns about the quality and appropriateness of insurance products, and to better manage balance sheet risks. For example, to reduce the prudential risks of insurance company failure through the sharing of tail risks via reinsurance and transfer onto capital markets. This is, to an important degree, an organisational and governance challenge requiring the attention of public policymakers. Regulators need to work with insurance firms, and indeed with firms across financial services, to promote the adoption of digital technologies in order to better meet these regulatory objectives, coordinating and if necessary managing the adoption of data and other standards to make this possible (McNulty et al., 2021).

What will be the final destination in the digital transformation of insurance in the UK? There is still a long way to go, but we envisage this paralleling the developments that have taken place in UK open banking (The Open Data Institute & Fingleton, 2019). What is now emerging is an evolution towards platform-based provision with an opening up of the value chain, sharing of data, and competitive provision utilising advanced data technologies. We envisage this affecting each stage of value creation, from customer acquisition through to underwriting and pricing, claims management through to risk modelling and risk sharing. Delivering the required digital transformation is not therefore the narrowly conceived responsibility voiced in the Kalifa Review of providing public support for start-up innovation. Rather, it is a broadly conceived responsibility for ensuring the required cooperation on standardisation and sharing of data, and on promoting the necessary transparency for proper assessment of risk and customer outcomes.

10.5 Conclusion

This chapter has examined the economics of public policy support for financial technology, criticising the narrow perspective of the Kalifa Review which focuses on public support of innovative start-ups (Kalifa, 2021). Market failures in both labour and capital markets justify start-up support, but this should be for innovation in all innovative industries, not just in finance. With regard to technology and financial services, there are bigger fish to fry. We argue that the central public policy challenge is supporting the digital transformation of the industry needed to address widespread historical problems in financial services. These include: the market and organisational failures that have led to such disappointing outcomes for clients and customers in terms of both cost and quality of service; the deeply embedded problems of fraud, inappropriate conduct, and market manipulation; and finally large scale prudential and systemic risks that came to a head in the global crisis of 2007–2008. While we agree with Philippon (2016) that FinTech is an opportunity to address these problems, they will not be obviously solved by promotion of FinTech as a sector. These points are illustrated with reference to the challenge of digital transformation in UK insurance, highlighting the role the public authorities need to play in coordinating the required standardisation and sharing of data, and on promoting the necessary transparency for proper assessment of risk and customer outcomes.

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CHAPTER 11

Conclusion: Fintech—A Perfect Day or Walk on the Wild Side?

Jonathan Williams

11.1 Introduction

The *Global Fintech Index 2020* envisages 60% of global GDP will be digitised by 2022. Across sectors, digitally enhanced offerings, operations, and relationships will drive growth (Findexable, 2019). At the fulcrum of this Fourth Industrial Revolution is a digitally enhanced financial services sector shaped by enabling technologies.[1] Leading the charge are financial technology (fintech) and big technology (bigtech) firms. To supporters, fintech is a game changer that will disrupt or decentralise existing market structures by unbundling traditional financial services, blur industry boundaries, revolutionise how firms create value, and deliver services in ways that will democratise financial services to yield welfare

[1] See https://www.weforum.org/focus/fourth-industrial-revolution.

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gains across global society (Frame et al., 2019; FSB, 2017; Philippon, 2020).[2] Notwithstanding, the World Economic Forum cautions against unblinkered optimism noting the "huge promise" but "potential peril" of market developments.

We offer a high-level review of fintech through the lens of the supranational agencies and multilateral institutions (*the Institutions*) charged with monitoring the impact of developments in market structure on the financial system and finessing the regulatory architecture.[3] Interest in fintech from a financial stability perspective is recent, becoming a priority of the Financial Stability Board (FSB) in 2016. Stability rests alongside other policy objectives pursued by various national authorities, such as, consumer and investor protection, market integrity, financial inclusion, and promoting innovation and/or competition.

In a series of ongoing reports, *the Institutions* assess matters pertaining to fintech. *The Institutions* like many academics use the FSB definition of 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" (FSB, 2017, p. 7). While the FSB expects fintech will facilitate significant changes in financial services, it does not envisage the core functions of intermediation fundamentally changing.[4] The benefits of technological change often take time and ambiguity exists over whether benefits will materialise fully.

The Basle Committee on Banking Supervision (BCBS, 2018) considers competition policy. New fintech entrants can increase market contestability facilitating improvements in firm-level and market-level efficiencies and realisation of welfare gains. New technologies enable fintech firms to lower transactions costs by ameliorating information asymmetries; in turn, customers receive tailored financial services at more affordable rates

[2] National governments like the UK government are devising and implementing industrial strategies that place innovation at the centre and are reshaping regulation in ways that support innovation. https://www.gov.uk/government/publications/regulation-for-the-fourth-industrial-revolution/regulation-for-the-fourth-industrial-revolution.

[3] See Ehrentraud et al. (2020) for an insightful cross-border overview of policy responses to fintech.

[4] The core functions of financial intermediation can reduce financial frictions, for instance, information asymmetries, incomplete markets, and negative externalities. Frictions could be related to misaligned incentives, network effects or behavioural distortions (FSB, 2017).

and faster speeds. Automation could reduce regulatory costs facilitating improvements in compliance. Policy initiatives to encourage competition in financial markets could benefit financial stability if markets fragment in ways that reduce the systemic risk potential of large incumbents. Fintech could increase consumer welfare through financial inclusion via wider access to financial services and financial deepening.[5]

Fintech is challenging the regulatory architecture to deal with complementarities and trade-offs between financial stability, competition, consumer and investor protection, and financial inclusion. Small compared to banking, fintech is fast growing (BCBS, 2018). Existing regulatory structures cover some micro-financial and macro-financial risks, but other risks are not yet covered.[6] Unresolved is whether to regulate firms or their activities (Andresen, 2016). If tech firms reside outside the regulatory perimeter yet perform core banking activities or should a tightening of regulations force activities into unregulated space, unmonitored vulnerabilities could build up. Evading regulations, intentionally or not, creates moral hazard and increases tail risks establishing a channel for financial instability (Aizenman, 2020). Consistent regulatory and legal frameworks can mitigate regulatory arbitrage and contagion, ensure resilience of economies, and capture welfare gains.

Emergent technologies have challenged banking before (Alt et al., 2018; Beck, 2020). One should assess if competition stemming from the new wave of technology-driven advances threatens banks differently from earlier technological developments. Previous experience suggests banks will fight off competitive threats and uncover ways to benefit from new developments. Banks, not all but certainly larger firms, are revising their business models and implementing new technologies to devise new value propositions or risk losing customers. This is being achieved by developing fintech services in-house or acquiring off the shelf fintech firms. Evolving market structures can expose vulnerabilities to known and

[5] Digital finance is expected to allow firms to scale up to reduce costs and widen access at greater speed, accountability, and efficiency. Greater financial inclusion could benefit underserved and unbanked customers both in advanced economies and emerging market developing economies (EMDEs).

[6] Micro-financial risks include credit risk, leverage, liquidity risk (run risk), maturity mismatch (rollover risk, price risk), operational risks including cyber risk and legal risk. Macro-financial risks include non-sustainable credit growth, greater interconnectedness and correlation, incentives for excessive risk-taking, procyclicality, contagion and systemic importance (FSB, 2017).

new risks, which can turn systemic if left unmonitored and improperly regulated.

It is too early to draw conclusions on future market structures. We can assess how the market structure is evolving. Seemingly, the future of banks involves a series of trade-offs, such as, how banks adapt to technological innovation and changes in customer demand; how competitors interact with banks; how regulators respond to benefits, risks, and competition arising from disintermediation; and on factors relating to the technology environment, regulatory framework, and ongoing financial system and political developments. *The Institutions* must monitor market developments to determine if and how fintech is disrupting financial services, and whether increases in competition lead to efficiency gains or financial instability (Navaretti et al., 2017).

11.2 The Institutions

The Institutions coordinate the design and implementation of rules and regulations to improve the functioning and safety of financial markets. They pursue three primary not mutually exclusive objectives. These are financial stability; competition and efficiency; and data rights and obligations. The FSB coordinates policy on financial stability. Competition policy can vary across borders although national bodies attempt to coordinate. Presently, global agreements on data rights and obligations in financial services are conspicuous by their absence. *The Institutions* are actively trying to close regulatory gaps notably cross-border shortfalls that are particularly evident.

We consider *the Institutions* with responsibilities for the financial sector and assess how responsibilities are adapting to incorporate finech. A high level of multilateral cooperation exists alongside the absence of unambiguous lines of demarcation for fintech. Competition and data could be as important as financial regulations in shaping the extent to which technology firms permeate financial services.

The FSB promotes international financial stability.[7] It coordinates national financial authorities and international standard-setting bodies (SSBs) with intent to develop strong regulatory, supervisory, and other financial sector policies. The FSB's priorities are to identify systemic risks in the financial sector, frame policy actions to address such risks, and oversee implementation of those responses. In July 2016, an additional priority required the FSB to monitor "potentially systemic implications of financial technology innovations, and the systemic risks arising from operational disruptions" (Carney, 2016, p. 2).[8] Hence, the FSB assesses how fintech is affecting the resilience of the financial system via an examination of risks emanating from new and incumbent financial institutions and activities, and the market infrastructure. The FSB uses existing risk assessment frameworks to evaluate systemic risks around financial institutions and infrastructure, as well as risks outside the regulated sector. Responsibilities for macro-financial issues are embedded in the FSB SIFI (systemically important financial institutions) framework. Micro-financial risks associated with fintech fall under the FSB's shadow banking policy. The Basel Committee's Core Principles can assess innovations in banking and interaction between banks and fintech firms (FSB, 2017). The tension between innovation and regulation is acknowledged in the proviso that the regulatory framework must ensure "it is able to manage any systemic risks that may arise from technological change without stifling innovation" (Carney, 2016, p. 6).[9]

The Bank for International Settlements (BIS, founded 1930) is owned by sixty-three central banks. It promotes monetary and financial stability and is a forum for discussion and cooperation. Specific BIS committees issue guidelines and standards for the financial sector that are relevant to fintech: the *Basel Committee on Banking Supervision* (BCBS)

[7] Established in April 2009, the FSB is the successor to the Financial Stability Forum (founded 1999). It was accompanied by expanding the G7 to the G20 countries. In spring 2021, the FSB has 24 member countries alongside international organisations (including the International Monetary Fund (IMF), World Bank, Organisation for Cooperation and Economic Development (OECD), European Commission and Central Bank (EC and ECB), Bank for International Settlements (BIS), and SSBs. Hosted at the BIS in Switzerland, the FSB plays a key role in promoting the reform of international financial regulation and supervision.

[8] Letter dated 19 July 2016 from FSB chair, Mark Carney, to G20 Finance Ministers and Central Bank Governors.

[9] See footnote 2.

considers prudential regulation of banks and cooperation on supervisory matters; the *Committee on the Global Financial System* (CGFS) focuses on improving the functioning and stability of global financial markets partly by identifying potential sources of risk; and the *Committee on Payments and Market Infrastructures* (CPMI) considers the safety and efficiency of payment, clearing, settlement, and other arrangements.

The IMF established an Interdepartmental Working Group on Finance and Technology and a High-Level Advisory Group on FinTech in 2016 and 2017, respectively, to study economic and regulatory implications of developments in finance and technology. The IMF assesses fintech's effects on cross-border capital flows, how the international monetary system is evolving, and the global financial safety net. Discussions between the IMF and its members on fintech topics take place through Article IV consultations, which typically involve a Financial Sector Assessment Programme (FSAP) and Financial System Stability Assessment (FSSA). In 2018, the IMF and World Bank launched the Bali Fintech Agenda, a framework on high-level FinTech issues countries should consider in domestic policy discussions (IMF, 2018). The Bali Agenda contains twelve policy proposals on how to enable fintech, ensure financial sector resilience, address risks, and promote international cooperation. The IMF/World Bank assess fintech's potential to widen access to financial services, deepen financial markets, and improve cross-border payments and remittance transfer systems; and evaluate the impact of fintech as part of an analysis of disruptive technologies and the digital economy (IMF, 2019).

Other international agencies consider fintech. The Financial Action Task Force (FATF) formulates international standards on anti-money laundering (AML) and combatting the financing of terrorism (CFT). The Organisation for Economic Cooperation and Development (OECD) Committee on Financial Markets considers fintech and the digitalisation of finance, and how they contribute to economic growth. Other SSBs, such as the International Organisation of Securities Commissions (IOSCO) and the International Association of Insurance Supervisors (IAIS) review implications of developments in fintech alongside accounting bodies. The IOSCO Objectives and Principles and the IAIS Insurance Core Principles are relevant for applications of fintech in securities markets and insurance, respectively, while the CPMI-IOSCO Principles for financial market infrastructures are relevant to fintech applications in payments, clearing and settlements (CPMI, 2020).

11.3 Banks, Market Power, and Business Models

Banks enjoy "special" status because of their role in the financial intermediation process and payments system. As licensed deposit-taking institutions, banks have "privileged" access to customer deposits markets, a source of cheap and stable funds,[10] and government safety-net arrangements (OECD, 2020). The "protection" of deposit insurance schemes, lender of last resort function, and implicit too-big-to-fail status are sources of competitive advantage that serve to instil *trust* in banks and the banking system.

Banks issue financial claims and transform the size, maturity, and risk characteristics of liabilities as they cross balance sheets to become assets which provides liquidity to borrowers. Frictions inhibiting intermediation impairs the efficient allocation of capital. Banks (and other financial intermediaries) are adept at overcoming information (adverse selection and moral hazard) and communications (match making) frictions (Boot et al., 2021). Banks eliminate frictions by collecting and processing large volumes of customer information. For instance, banks assess and manage credit risk by screening loan applicants and monitoring borrowers' behaviour to ensure compliance with contractual terms. Engaging in repeat transactions and re-using proprietary information improves the efficiency of monitoring (and is a source of scale economies). Relationship banking and product distribution channels like branches resolve communication problems.

However, banks could use skills in information processing and communications to exploit market power. Boot et al. (2021, p. 4) note that "private information generates informational capture as outside competitors face adverse selection" while "search, switching, and transportation costs lead to communication-related 'spatial' capture, which allows banks to price discriminate among customers". Frictions and licensed status are barriers to entry which dampens contestability in financial markets.

[10] This constitutes a funding cost subsidy for banks. Petralia et al. (2019) report estimates of this subsidy which range from 15 to 250 basis points. Grimaldi et al. (2019) estimate the subsidy for Swedish banks and find it has fallen from a height of 250 bp in 2009 to 25 bp in autumn 2018.

Market power/rent extraction has unambiguous and negative connotations for consumer welfare.[11]

Irrespective of market power issues, in banking competition policy is cognisant of a trade-off between competition and financial stability (Schaeck & Čihák, 2014). Until recently, regulators have granted banks some degree of market power on grounds that removing barriers to competition could incent greater risk-taking if the outcome was to compress net interest margins and profit (Berger et al., 2009). This charter value hypothesis attaches positive outcomes to licensing, for instance, making banks more forward-looking, and incentivising relationship building to establish the *trust* of customers. Thus, market power could incent lower risk-taking, which reduces bank instability and systemic risk (Boot et al., 2021).

Banking is heterogeneous. Banks are often classified by ownership and size. Such characteristics influence a bank's activities and choice of business model. An assessment of business models could indicate which might be more susceptible to competition from FinTech. It is worth emphasising that despite claims fintech will facilitate disintermediation at banks' expense, the fintech sector is small compared to banking with the bulk of fintech services in payments, which resides outside the regulatory perimeter. Boot et al. (2021) outline two ways in which fintech could prove highly disruptive: first, if new communications channels enable fintech firms to circumvent banks' distribution networks and offer financial services absent a balance sheet; second, if digital platforms insert themselves between banks and customers to capture rents.

Large systemically important banks and other larger firms operate as universal banks with activities spanning retail and wholesale banking, investment banking, trading, and insurance. Each activity faces potential competition from fintech firms. For instance, banks' retail lending decision-making is mostly transactional, automated, and based on credit scoring. Corporate lending decision-making, especially to large customers, uses hard and soft information gleaned from relationship banking and involves credit committees. Small and medium-sized banks are more reliant on traditional intermediation and serve smaller retail

[11] Proprietary information is a source of market power for banks that customers value and willingly pay for via higher interest rates and/or fees, say, on loan commitments. Imperfect information and weakly contestable markets can lead to credit rationing (Stiglitz & Weiss, 1981) to the detriment of financial inclusion.

and corporate customers. Smaller firms resolve information problems by building relationships with opaque customers like SMEs possibly underserved by larger banks.

The literature on bank business models attests that choice of business model affects performance outcomes and behaviour. Based on cluster analysis of balance sheet structures, researchers have identified commonly used business models: *Investment*, *Wholesale*, *Diversified Retail*, and *Focused Retail* (Ayadi & de Groen, 2016); *Specialised*, *Diversified*, *Trader*, and *Investment* (Hryckiewicz & Kozlowski, 2017); *Specialised Commercial Banks*, *Specialised Investment Banks*, *Diversified or Universal Commercial Banks*, and *Diversified or Universal Investment Banks* (Merck Martel et al., 2012). The choice of business model impacts bank stability (Kohler, 2015) while the structures of banks' assets, liabilities, income, and capital affects performance (Mergaerts & Vander Vennet, 2016). Adopting a financial markets valuation approach, Venturelli et al. (2020) find market-oriented banks achieve a better risk-return trade-off, which they attribute to higher levels of trading and other activities, such as custody, administration of securities, underwriting, portfolio management, and advisory service. Examining changes in business models, Ayadi et al. (2020) find higher risk and lower profitability banks are more likely to change and in ways that foster improvements in bank stability, profitability, and cost-efficiency. One can draw inferences on the impact of fintech and how banks might respond to disintermediation and competition.

11.4 Fintech Innovations and Associated Risks

The BCBS (2018) categorises fintech innovations into three product sectors relating to core banking activities: credit, deposit, and capital-raising services; payments, clearing, and settlement services; and investment management services.[12] Market services or new technologies support product areas, for instance, cloud computing, AI, and DLT. Termed enablers, fintech impacts the financial sector by utilising innovative technologies to reduce frictions and realise stability and societal gains. Classifying fintech developments by economic function isolates financial

[12] In their taxonomies, Thakor (2020) and the FSB (2017) include insurance as a fourth product.

stability implications of fintech by focusing on activities and outcomes rather than on firms and/or underlying technologies.

The FSB (2017, p. 11) predicts "material" implications for market structure resulting from changes to customer preferences, technology, and financial regulation either singularly or via interactive effects. Carney (2017) considers the impact of fintech on the financial services value chain. His hypothetical universal bank performs five core activities: customer relationships; retail and commercial banking; wholesale banking; payments services; wholesale payments, clearing, and settlement. Against each activity, Carney maps corresponding fintech services, qualifies their benefits, and identifies attendant risks associated with fintech's development and disruptive influence on banking. Table 11.1 shows the mapping alongside a synopsis of each activity's benefits and risks.

How market structures evolve is a critical issue. A priori unbundling is expected to increase competition and market contestability, improve efficiency, and widen consumer choice leading to welfare gains.[13] Banking markets are commonly oligopolistic and characterised by explicit and implicit entry barriers; for instance, prudential and licensing requirements, network externalities, high fixed production costs, and values customers place on trust and reputation. While fintech's user-friendly platforms and fast onboarding can incentivise switching behaviour, especially tech-savvy younger generations, bank customers are renowned for loyalty. It is uncertain whether, and/or to what extent, fintech will challenge banks' market power, suggesting welfare gains might not materialise as expected.

An alternative scenario envisages market power shifting from banks to a small number of large, dominant tech firms. Fintech firms can achieve powerful network externalities due to their scalability with potential to create natural monopolies, which could instigate consolidation of financial services and increase concentration risk. This view perceives fintech firms as profit maximisers that fail to internalise the public good feature of financial stability (Aizenman, 2020). Rent extraction and associated societal costs remain.

The FSB (2017) identifies four potential benefits to financial stability from fintech. First, if decentralisation reduces entry barriers and enables smaller firms to compete more effectively, for instance, robo-advisory services and use of big data and automation in originating credit and

[13] Degryse et al. (2019) provide an excellent review of competition in banking.

Table 11.1 Core banking and Fintech: competitive outcomes and risks

Core banking	*Fintech Services and* Competitive Outcomes	*Risks*
Retail payment services	Digital wallets, eMoney, cross-border payments *Fintech firms capture customer data and relationships from incumbent banks*	New concentration risk and single point of failure risks: • If banks rely on common hosts of online platforms/cloud
Customer relationships	Aggregators, price comparison and switching tools, robo-advisors, identity *Fintech's user-friendly platforms and fast onboarding challenge banks' legacy IT systems*	Weakening of bank-customer relationships: • Increases deposit volatility and liquidity risk • Pressurises bank profit and incentivises risk-taking
Retail and commercial banking	P2P lending, big data analytics, receivables *Fintech widens access to credit and reduces decision times. Big data: tailor services to maximise customer satisfaction; discipline credit underwriting; enable firms to borrow against invoice receivables*	Future business model risks and uncertainties: • Will P2P evolve without conventional risks? • How stable is P2P lending through the business cycle? • What are the tech lenders' tolerances to losses?
Wholesale banking	High-frequency trading Risk management algorithms	Excess volatility in asset prices: • From herding and/or highly correlated price movements Impaired market functioning: • If market liquidity is withdrawn during market disruptions

(continued)

Table 11.1 (continued)

Core banking	*Fintech Services and* Competitive Outcomes	*Risks*
Wholesale payments, clearing and settlement infrastructure	Distributed ledger technologies *Fintech could improve accuracy, efficiency, and security of processes, and enable better regulatory compliance. Cost savingsexpected*	Critical infrastructure providers High operational risks and costs Cyber risk

Source Adapted from Carney (2017), BCBS (2018) reducing compliance costs. Diversification can lessen the probability of contagion effects from firm failures. Second, more contestable markets and application of productivity-enhancing technologies in front and back-offices realises efficiency gains. Third, greater transparency improves quality of information to enhance measurement and pricing of risks. Fourth, as a provider of "debt-based alternative finance", fintech widens access to financial services yielding increases in financial inclusion for underserved customer groups. Alternative finance is especially important in EMDEs that have benefitted from applications like mobile banking. Greater inclusion, say, through equity crowdfunding and fintech lending, can diversify investment risk.

The Institutions classify risks to financial stability emanating from technology as micro-financial and macro-financial risks (FSB, 2017). Micro-financial risks fall into financial and operational risks and indicate vulnerabilities that might arise if fintech underestimates risks and/or shocks disrupt markets. Financial risks include credit intermediation arising from mismatches in maturity transformation, leverage, and liquidity (whether a bank or fintech provides the service). Marketplace lending poses a competitive challenge to retail banking though several uncertainties abound. First, can marketplace lending (P2P) evolve without assuming conventional risks (maturity transformation, leverage, and liquidity mismatches). Second, which quality of underwriting standards will emerge. Third, how might fintech lenders tolerate losses. Regulators must monitor the effects of increased competition. Greater fintech adoption suggests softening of customer relationships and fewer cross-selling opportunities for banks; this could destabilise bank funding and increase liquidity risk to pressurise net interest margins and profitability. Adversity often induces risk-taking to the detriment of financial stability.

Banks and fintech firms must manage operational risk including cyber risk.[14] Single point of failure risks become more likely if players rely on a small number of shared hosts, for instance, providers of online banking services or cloud computing services. Disruptions to third-party services, say, cloud computing services could undermine systemic stability if services become dominated by large firms. Cyber-risk is expected to rise as larger numbers of different firms and systems become connected. Yet,

[14] Operational risks generally arise from information systems, human error, managerial competencies, and external shocks.

fintech-enabled competition and diversity could lessen systemic severity of a single cyber-attack.

Legal and regulatory risks can materialise from weaknesses in governance and control of processes. Risks arise because fintech *firms* rather than the *activity* they perform lie outside the regulatory perimeter or are subject to lighter regulation. Ramifications exist for partnerships between well-regulated and weakly regulated firms. Regulatory treatments of fintech issues, such as privacy and data ownership vary across jurisdictions inferring that cross-border activities, say, in payments constitutes a challenge for regulatory frameworks. Lastly, business risks of financial market infrastructures can arise if critical financial services are adversely affected by other parts of a firm's business.

Innovations and fintech activities could amplify macro-financial risks to undermine financial stability. Increasing interconnectedness of larger numbers of different types of firms, and sharing of data and at faster speeds, create challenges in maintaining the security of the ecosystem. Domino effects/commonalities transmit contagion risk, say, reputational contagion risk should problems at a single fintech lead to sectoral concerns. Automation and/or limited human involvement, for instance, in trading creates new sources of contagion.

Procyclicality in lending, pricing of risk premia, and deleveraging under distress exacerbate downturns. Fintech activities like marketplace lending may face bigger changes in sentiment potentially disrupting credit markets. Ambiguity resides as to how credit standards will evolve and their accuracy. Whereas marketplace lending might increase financial inclusion, wider access can create dependencies and it is unknown how stable marketplace lending will be through-the-cycle. Automated trading based on common algorithms may cause herding behaviour to disrupt diversification and amplify swings in asset prices. While electronic trading has created market liquidity, it is uncertain how markets would respond to shocks and whether liquidity would be withdrawn when most required.

Excess volatility or market overreactions can create liquidity and solvency problems that impair asset and credit markets. Commonality of business models constitutes a transmission channel. The speed at which fintech firms' complete transactions can increase volatility. Aggregators, for instance, move cash quickly around the banking system in response to changes in prices and relative performance. This might increase the volatility of bank deposits to the detriment of bank liquidity positions.

The increase in numbers of systemically important firms deemed too-big-to-fail could amplify risks, say, by incentivising moral hazard behaviour that encourages risk-taking to exploit safety net arrangements. The emergence of dominant firms creates market power issues including anti-competitive behaviour like predatory pricing. New monopolies could emerge if a new technology comes to dominate activities essential for providing financial services, such as collection and use of customer information.

11.5 The Evolving Market Structure

The emergence and fast growth of fintech has introduced new competitors and new technologies leading to predictions that fintech will democratise financial services and create economic and welfare gains. It is too early to say how market structures will evolve. Certainly, the paucity of data on fintech hinders any assessment. Financial market incumbents like banks hold comparative advantages in terms of lower costs of capital, large numbers of customers, and intimate knowledge of/compliance with regulations. Many financial markets are oligopolistic and dominated by a few, large firms with plentiful resources to meet competitive challenges. Fintech firms appear hesitant to undertake banking activities suggesting wariness of crossing the regulatory perimeter and having to comply with prudential regulations. Partnerships between fintech firms and banks are one solution that seeks to utilise each partner's comparative advantages. Larger banks, however, are developing fintech services in-house and/or acquiring off the shelf fintech firms.

11.5.1 The Impact of COVID-19

Since 2020, use of fintech services has increased sharply especially in digital payments and remittances (World Bank & CCAF, 2020).[15] Fintech is perceived to support national regulatory objectives, particularly, financial inclusion (70% of respondents), market development (61%), adoption of digital financial services (53%), and promoting competition (47%). Fintech's highest perceived negative impact is on consumer protection

[15] The World Bank/CCAF surveyed 118 central banks and other regulatory financial bodies from 114 jurisdictions between June and August 2020. Two-thirds of respondents reside in EMDEs.

with the pandemic increasing risks in cybersecurity (78% of responses place in top three risks), operational risks (54%), and consumer protection (27%).

CCAF et al. (2020) surveyed fintech firms to assess the impact of the pandemic.[16] In H1 2020 and on average, fintech firms' transactions numbers and volumes increased year-on-year by 13 and 11%, respectively. Fintech firms in EMDEs achieved faster growth (numbers, 15%; volumes, 12%) than counterparts in advanced economies (11, 10%). Some sectors achieved above-average growth in transactions volumes, for instance, digital asset exchanges, digital payments, digital savings, and WealthTech (over 20%). Growth was more modest in digital banking, digital identity, and regtech (around 10%). However, digital lending has struggled with contractions in transactions volumes and numbers of new loans issued (8 and 6%, respectively), and increased defaults on outstanding loans (9%).

Fintech firms responded to the pandemic by making changes to products or services typically fee or commission reductions/waivers, and changes to qualifications/onboarding criteria. The pandemic has negatively affected firms' capital reserves, valuations, and outlook on future fundraising. Many firms perceived an increase in cybersecurity risk and introduced enhanced fraud/cybersecurity features. Increases in liquidity risk and FX exposure risk were also reported.

11.5.2 Fintech Adoption Rates and Impact on Banks

The latest Global FinTech Index of the adoption rate of fintech services shows a sharp upward trajectory: from 16% (2015) to 33% (2017) to 64% (2019) (EY, 2019). Classifying fintech services as either "disruptive" (incumbents offer the service, say FX trading), or "invented" (a new service based on technological developments, say, P2P lending and mobile phone payments),[17] EY considers fintech a "sophisticated" competitor with global reach and no longer a disruptive influence. Demarcation lines between fintech firms and incumbents are blurring as banks and other

[16] CCAF et al. surveyed 1385 fintech firms operating in 169 jurisdictions between 15 June and 18 August 2020.

[17] Consumer awareness of "invented" fintech services can be extremely high. For instance, 89% of consumers are aware of the existence of in-store mobile phone payment platforms, and 82% aware of P2P payment systems and non-bank money transfers (EY, 2019).

Table 11.2 Consumer fintech adoption: an international perspective[a]

Rate (%)	*Country*	*Rate (%)*	*Country*
87	China, India	58	Australia
82	South Africa	56	Spain
76	Colombia	51	Italy
75	Peru	50	Canada
73	Netherlands	46	USA
72	Mexico	42	Belgium and Luxembourg
71	Ireland, UK	35	France
67	Argentina, Hong Kong, Singapore, South Korea	34	Japan
66	Chile		
64	Brazil, Germany, Sweden, Switzerland		

Note [a]Fintech adopters as a percentage of the digitally active population
Source Adapted from EY (2019)

incumbents now offer fintech services, which is driving fintech adoption rates (EY, 2019). Table 11.2 provides an international perspective on fintech adoption rates.[18] Adoption is highest in EMDEs, such as China, India, and Latin America. In advanced economies, rates are highest in the Netherlands, UK, and Ireland, partially reflecting development of open banking. The adoption rate for SMEs is 25%; 56% of SMEs use a banking and payments FinTech service, and 46% a financing fintech service.

Chen et al. (2020) estimate the value of fintech innovations from published fintech patent applications in the US from 2003 to 2017. Values are indicative of gains to financial services firms from developing in-house fintech services. Private companies and individuals hold a higher percentage of patents (62.7%) than technology companies outside the financial sector (57.8%). Determining patent value through examination of stock market reactions to filing disclosures, the private value of a fintech innovation is $46.7 million (at 2017 prices) far outstripping the median private value for other financial innovations ($3.1 million). Blockchain and robo-advising are the most valuable types of fintech innovations. Value effects exhibit cross-sectional variation emanating from two sources: the relative disruptiveness of the underlying technology; and

[18] EY (2019) constructs the adoption index from survey evidence obtained from 27,000 customers in 27 markets.

whether the innovator poses a competitive entry threat to the sector. Significantly more industry value is destroyed when the underlying technology is disruptive and when it originates from fintech start-ups. From the perspective of incumbents, larger firms are more able to withstand disruptive outside innovation than smaller counterparts, but this ability is linked to firms' R&D expenditures.

Cheng and Qu (2020) devise a FinTech Index to analyse the development of fintech at banks in China from 2008 to 2017. Although bank fintech is developing along an upward trajectory, variation exists between types of banks and across technologies; internet technology is fastest growing and artificial intelligence lagging. Bank fintech is associated with improvements in credit risk. This reflects fintech's beneficial effect on the efficiency of banks' risk management and/or internal governance and internal control processes.

Hong et al. (2020) investigate the effect of fintech adoption on risk-taking using account-level data obtained from China's Ant Group, which reveals an individual's investment and consumption behaviour. While fintech adoption fosters household risk-taking, risk-tolerant investors benefit the most. Fintech adoption helps individuals move closer to their optimal risk-taking levels with positive implications for financial inclusion.

Phan et al. (2020) consider the impact of fintech firms on bank performance. Their evidence from Indonesia exemplifies an emerging market and a country where the number of fintech firms has grown strongly (by roughly seven per annum over 1998–2017 to around 130 fintech firms). Increasing numbers of fintech firms correlate with significantly lower net interest margins, profitability, and yields on earnings assets at banks. Negative effects are felt by smaller and, particularly larger banks, and older banks. That fintech positively affects aspects of younger bank performance suggests younger firms can be expected to successfully adopt new technologies.

11.5.3 Impact of Fintech on Core Banking Activities

Petralia et al. (2019) survey nearly 60 market participants (banks, fintech, bigtech) to determine how competition is affecting provision of banks' primary functions (maturity transformation; payment services; information processing; risk pooling/liquidity provision). Respondents selected financial products and services: (1) most affected by technological developments now; (2) likely to be affected over the next five years; and (3) seeing the greatest competition. Across (1) to (3), payment services are most important followed by products and services under maturity transformation and forms of information processing facing digital disruption. Survey respondents claim that technology developments have enabled improvements in service quality and better understanding of customer behaviour. Over time, better data, algorithms, and AI are expected to improve regulatory and security processes and success rates for detecting and preventing fraud.

Respondents answered two open-ended questions: (1) how are technological developments most significantly impacting existing products and services? (2) thoughts on the structure of the financial services industry in five years. For (1) most bank respondents cited digital transformation as a priority to improve efficiency and products, reduce product development times, downsize branch networks, and improve risk management particularly compliance. However, digital transformation is constrained by regulatory and compliance costs, customer protection legislation, the low interest rate environment, and competition.

In five years, respondents expect a more diverse ecosystem with banks, fintech and bigtech firms competing and partnering at the same time. It is unclear how this ecosystem will evolve. With consolidation appearing necessary, some respondents consider small-to-medium-sized banks to be targets whereas others look at larger banks particularly in Europe and those unable to effectively evolve their business model.

11.5.4 Fintech and Credit

Cornelli et al. (2020) consider the transformation of credit markets following the emergence of alternative sources of credit. Using data on fintech credit volumes from the Cambridge Centre for Alternative Finance (CCAF), Cornelli et al. examine new flows of fintech credit across global credit markets. The analysis distinguishes fintech credit from bigtech credit: typically, fintech credit is provided via decentralised platforms which match borrowers with lenders; for bigtech firms, lending accounts for only a small part of mainly non-financial business.

The global market for alternative credit reached $795 billion in 2019. Although slowing down, growth averaged 15% per annum over 2017–2018 and 2018–2019. In 2019, bigtech credit accounted for around 72% and fintech roughly 28% of total alternative credit. Table 11.3 shows the

Table 11.3 Global credit markets—alternative credit and total financial sector domestic credit

		US \$ millions			*Change 2018–2019*			*2018*
Rank 2019	*Country*	*Bigtech*	*Fintech*	*Tot. Alt*	*Bigtech*	*Fintech*	*Tot. Alt (%)*	*TA/Dom Credit (%)*
1	China	515,878	110,836	626,714	42	−49	8	1.9
2	US	8247	70,208	78,455	704	22	34	0.3
3	Japan	25,694	2173	27,866	35	136	40	0.1
4	UK	113	11,476	11,589	21	23	23	0.2
5	Indonesia	1116	3803	4918	74	163	136	0.5
6	Russia	2312	273	2585	14	135	20	0.2
7	Kenya	2001	51	2052	100	62	99	3.0
8	France	442	1371	1813	119	112	113	0.0
9	Brazil	292	1460	1752	109	135	130	0.0
10	India	170	1115	1285	0	123	92	0.0
	Total	572,229	223,308	795,537	44	−25	16	0.6

Source Adapted from Cornelli et al. (2020)

top ten ranking countries in 2019. China has the largest flows of alternative credit followed by the US, Japan, and the UK. A strong emerging markets presence characterises the leading countries. Whereas credit from bigtech firms is more important in China and Japan, fintech credit holds sway in the US and UK. Table 11.3 reports growth rates over 2018–2019, and the ratio of (the flow of) total alternative credit-to-(the stock of) total domestic credit by the financial sector. This metric reaffirms alternative credit markets are small in comparison to traditional bank lending. The analysis suggests alternative credit markets complement traditional credit markets.

The entry of new competitors into credit markets raises important questions for incumbent firms and their competitiveness, regulators tasked with monitoring vulnerabilities and risks, and policymakers interested in households' borrowing and consumption patterns. For instance, which borrowers use the services of new entrants, whether new entrants attract and serve underbanked customers segments or customers with better creditworthiness, whether new entrants help customers improve their credit standing. In the US, fintech firms have targeted the large consumer credit market. Di Maggio and Yao (2020) use individual-level data to examine the market for personal credit for fintech and traditional lenders. Proponents believe fintech can reach customer segments that banks find unprofitable, which could reduce credit rationing and information asymmetries.

FinTech lenders enter the personal credit market by targeting less creditworthy individuals. Increases in market share precipitate advances in credit to more creditworthy borrowers. On average, personal credit from fintech firms is around 3% more expensive than traditional lenders. However, the difference in loan rates between the two types of lender is lower in areas where the market share of fintech is lower. This implies fintech lenders use an aggressive pricing strategy to attract new customers.

Observed variation in loan rates reflects information in customer credit reports for fintech lenders. This suggests fintech firms base their credit decisions on hard data indicating a soft information deficiency.[19] Notwithstanding, loans granted by fintech firms have significantly higher

[19] Flögel and Beckamp (2020) confirm the importance of soft information in reducing information problems and enhancing the screening and monitoring of loans to SMEs by regional savings banks in Germany. A scenario in which fintech lenders displace regional savings banks in the SME loans market is hypothesised to result in lower access to credit.

default probability than loans originated by traditional lenders by an estimated, economically meaningful 1.1%. Fintech lenders face adverse selection. Over-reliance on hard data leads to credit being supplied to borrowers rejected by banks. Fintech lenders account for this in their pricing which better predicts default probabilities (by 20%). With borrowers increasingly likely to use fintech lenders, positively affecting the lifetime value of loans, higher defaults do not produce worse outcomes for fintech lenders (Di Maggio & Yao, 2020).

Using loan-level data from a fintech in India, Ghosh et al. (2021) uncover a theoretical synergy between the growth of both fintech lending and cashless payments. Wider use of cashless payments produces borrower information outside of lenders; that borrowers expect lenders to screen based on verifiable information boosts usage of cashless payments. Since cashless payments vary in verifiability, the fintech lender uses this information to reduce adverse selection and be more efficient in screening high from low-quality applicants. Greater use of cashless payments improves borrowers' chances of obtaining loans, and at lower rates than previously paid to traditional lenders. For loans at comparable interest rates, borrowers that use cash have higher probability to default.

Yang (2021) considers the importance of trust in banks as an implicit barrier to entry to fintech in credit markets. Using the Wells Fargo scandal as an exogenous shock to trust in banks, an increase in exposure to the scandal is associated with an increase in the probability of borrowers using fintech firms as mortgage originators. The shock affects all banks irrespective of the fact the scandal occurred at Wells Fargo. Yang examines the role of trust in fintech adoption for minority borrowers. Whereas minority borrowers do not have a smaller loss of trust, they have a smaller increase in the adoption of fintech, which suggests minorities perceive trust as less critical in fintech adoption. The increase in fintech adoption resulting from loss of trust in banking does not affect fintech firms' loan pricing, which is consistent with fintech firms' use of hard data to price credit. Promotion of fintech adoption is unlikely to lead to higher loan rates at fintech firms.

11.5.5 Linkages Between Fintech and Banks and the Financial Ecosystem

One option for incumbents is to acquire an off the shelf fintech firm. Pancotto et al. (2021) consider bank acquisitions of fintech firms and investigate which factors influence decisions to acquire. Acquisitions are more likely by better capitalised banks and more liquid banks, banks led by longer tenured CEOs, and banks with higher proportions of females on boards. Banks led by younger CEOs and banks with lower IT expenditures are also more likely to acquire fintech firms. In contrast, banks with higher IT expenditures are less likely to acquire, which suggests these banks favour in-house development of fintech services.

Two features could motivate partnership agreements. First, customers adopt banking services from non-traditional suppliers because of low-cost offerings, ease of use, faster service, better features, and personalised products. Second, despite banks increasing IT expenditures, customers appear largely dissatisfied.[20] Despite the rationale for fintech–bank partnerships, specific factors appear to inhibit success. For instance, the existence of cultural gaps and difficulties in communication between partners; and poor choices of partner which can cause project failure (Capgemini, 2020). Despite banks' investing in front offices, their middle and back-office functions impact customer perceptions and are burdened by legacy IT, which hinders banks from creating "superstar" products and developing "long tails".

Prospects for bilateral partnership agreements appear to be waning due to the emergence of fintech ecosystems involving incumbents, fintech firms, and other non-financial sector firms. The emergence of new technologies and increasing digitisation are factors with potential to shift the financial ecosystem, for a long time characterised by banks' acting as trusted advisors to a loyal customer base. Arslanian and Fischer (2019) identify two interrelated developments: platformisation and open banking. In a platform-based marketplace model, the platform's owner facilitates exchanges between decentralised customers and producers. Open banking requires banks to share customers' financial data with third parties (subject to consent), which should establish a marketplace for financial services and facilitate more competition and innovation in the sector. That open banking regulations will end banks' monopoly

[20] Banks increased IT expenditure by 4% per annum over 2016–2019. However, 50% of customers did not receive an integrated banking experience; 60% could not make direct banking payments on different platforms; 58% could not access all accounts from a single platform. The abandonment rate of UK banks reached 56% in 2018 from 40% in 2016 (Capgemini, 2020).

on ownership of customer data has market power/welfare implications alongside shocks to bank revenues and business models.

It is worthwhile to consider which, if any, firms could come to dominate open banking. Banks, particularly the largest, are in pole position due to their "ownership" of customer data, financial sector acumen, and capital to respond to market developments. Bigtech firms are banks' main other competitors and offer IT capabilities in place of financial know-how. Bigtech firms are expanding into financial services and reports suggest customers' trust in bigtech matches that in banks. Full commitment to open banking requires substantial investment, which heightens probability that banks and bigtechs will partner up, and, increasingly that fintech firms will move into any unoccupied spaces.

We can glean possible outcomes associated with open banking using a theoretical model that considers competition between a bank and a fintech in the credit market when borrowers can share information (He et al., 2020). Absent open banking, the traditional bank holds an information advantage or better screening ability than the fintech (even if the fintech uses advanced data analysis algorithms). Open banking induces competition. Data-sharing enables the fintech to utilise its analytical algorithms to improve credit screening and to even surpass the bank's screening abilities. The model supports the proposition that open banking favours the fintech. Since data sharing is voluntary, in a perverse outcome all borrowers are worse off with lower welfare even though the financial sector is more profitable.

11.5.6 Fintech and Financial Inclusion

Despite technological advances, the unit cost of financial intermediation remained near to 200 basis points for around 130 years (Philippon, 2015). Recent estimates show a decline in unit costs following the GFC (Philippon, 2020). If fintech improves the efficiency of financial intermediation, consideration should be given to how the gains will be shared, and whether fintech will democratise financial services or widen inequalities.

Philippon's (2020) theoretical framework shows FinTech could reduce the cost of financial intermediation but regulatory changes are needed for fintech to realise its potential. In the case of robo-advisory services, technological advances are changing the nature of fixed and variable costs in ways that will widen access for less wealthy customers but may not reduce inequality across all customer groups. Similarly, fintech lending could reduce discrimination (statistical biases) in credit markets but also reduce the effectiveness of existing regulations to protect minorities.

Sahay et al. (2020) measure the contribution of digital finance (payments) to increasing financial inclusion. They construct a digital financial inclusion index and a traditional financial inclusion index (for financial intermediaries) for a sample of 52 EMDEs covering 2014–2017 (digital) and 2011–2017 (traditional). Pre pandemic, digital finance made a positive, significant contribution to financial inclusion (financial intermediation's contribution remained constant). That digital financial inclusion is positively correlated with future GDP growth suggests fintech could contribute to growth and lower income inequality.

Jagtiani and Lemieux (2018) examine fintech lending for unsecured consumer credit against comparable lending by traditional banks to determine whether fintech can penetrate markets underserved by banks. Using loan level data from LendingClub and credit card loans data from banks' Y-14M reports, fintech lending penetrates underserved areas characterised by highly concentrated or less competitive banking markets, greater preponderance of lower income borrowers, and low branch density. Further expansion of fintech services could fill credit gaps by supplementing existing consumer credit which can boost financial inclusion.

11.5.7 Scenario Analysis

The BCBS (2018) considers five forward-looking scenarios and associated risks (see Table 11.4). The scenarios are not mutually exclusive. The first is "Better Bank", which envisages banks responding to competition by invigorating their business models with enabling technology to provide customers with new value propositions. Execution risk and outsourcing are potential concerns alongside increased cyber risk. The four other scenarios range from "New bank" in which banks face strong competition from new technology banks, such as challenger banks and neobanks, to "Disintermediate bank" which premises the end of banking and balance sheet intermediation with all customers' financing requirements provided by platforms and technologies. From a financial stability perspective, the inherent risks include incentives for banks to take excessive risks as revenue streams and profits are competed away; supervisory challenges from monitoring third party relations; consumer protection, data privacy and security; greater interconnectedness and increased concentration risk

Table 11.4 Forward-looking scenarios: features and risks

Potential scenario	*Features*	*Risks*
Better bank	Banks' digitise to: • Retain customer relationships • Revise business models—enabling technologies • Develop new value propositions	*Execution risk*: from managing/implementing changes in technology and business processes *Operational risk*: rises due to cyber risk/outsourcing, migrating from legacy IT
New bank	Technology-driven banks full-service digital platforms: • Provide cost-effective, innovative services • Incumbents burdened by legacy IT	*Safety and soundness*: new tech firms win customers leading to loss of revenue/profit at banks Incumbents' scale/size hinders digitisation and modernisation
Distributed bank	Fragmentation of financial services: • Fintech firms and incumbents carve out niches • Partnerships, third-party relationships develop • Competition to own the customer relationship	• Monitoring and managing end-to-end transactions across multiple parties' challenges banks' risk management processes and bank supervisors • Consumer protection/data usage; interconnectedness; lack of accountability
Regulated bank	Technology firms control customer relationships: • Tech firms use licensed banks for lending, deposit-taking, and risk management services	• Limited ability of banks and supervisors to monitor end-to-end transactions and systemic risk • Increased automation: raises concerns over consumer protection, data privacy and security • *Concentration risk*/TBTF: arising from small numbers of platforms/bigtech firms become too large

(continued)

arising from service providers; the possibility that bigtech firms and other fintech firms that reside outside the regulatory perimeter become dominant and abuse market power.

While it is too early to say which, if any, of these forward-looking scenarios is emerging let alone which, if any, will come to dominate,

Table 11.4 (continued)

Potential scenario	*Features*	*Risks*
Disintermediate bank	End of banks: • No need for trust and balance sheet intermediation • Platforms/technologies service customer financing needs	• Activities occur beyond the regulatory perimeter • Weaker standards, oversight/monitoring of systemic risk • Greater risk exposure for customers

Source Adapted from BCBS (2018)

available evidence shows incumbents digitising and modernising (Better bank), and of the New bank scenario in countries, such as the UK and US, the Netherlands, Germany, and China. Features of the Distributed bank scenario are observed in joint ventures and third-party agreements between banks and fintech firms. Examples abound of the Relegated bank, which provides services to a tech firm that owns the customer relationship; for instance, bigtech firms using their social media platforms to collect and leverage customer data to offer customers tailored financial services from other providers including banks. Though the Disintermediate bank scenario may seem far-fetched, examples exist including P2P lending platforms implementing credit scoring and approval processes that are trusted by customers, and cryptocurrencies being used for payments and value transfers using DLT technologies and absent incumbent banks.

11.6 Concluding Remarks

This chapter has reviewed the light and dark sides of fintech through the lens of *the Institutions*. Fintech is fast growing and offers opportunities to enhance quality of financial services, improve customer satisfaction, increase financial inclusion, support economic growth, and welfare gains. Yet, potential exists for known and new risks to emerge and threaten financial stability, growth, and welfare. Notwithstanding, fintech firms are yet to reach the scale whereby they constitute a systemic risk (FSB, 2017). Nevertheless, financial markets are inherently oligopolistic with market power issues that competition policy is yet to resolve. Noting the possibility of a fintech or bigtech firm gaining market power and extracting rents, *the Institutions* must resolve if *activities* should fall within the regulatory perimeter even if the *firm* does not. The implication is for regulators to address vulnerabilities as they come to fruition by adapting existing regulatory frameworks.

The appetite of fintech firms to provide core banking services appears diminished by the prospect of crossing regulatory boundaries. Together with banks' revising their business models to capture opportunities afforded by new technologies, cooperation might prove more fruitful than full-blown competition. Recent evidence is supportive: banks are developing in-house fintech services and/or acquiring off the shelf fintech firms; partnership agreements are plentiful (irrespective of success); fintech is boosting financial inclusion by helping to complete markets for underserved customers. In sum, available evidence implies fintech is complementing rather than disrupting traditional finance (for the time being at least).

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