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The impact of the FinTech revolution on the future of banking: Opportunities and risks

Victor Murinde [a], Efthymios Rizopoulos [b,*], Markos Zachariadis [b]

[a] Centre for Global Finance, School of Finance and Management, SOAS University of London, Thornhaugh Street, Russell Square, London WC1H 0XG, UK
[b] Alliance Manchester Business School, University of Manchester, Booth St W, Manchester M15 6PB, UK

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ABSTRACT

The financial technologies (FinTech) revolution is in full swing globally. In this paper, we review the burgeoning literature on FinTech and FinTech-enabled services, focusing on the opportunities and risks for banks. Using high quality bank level data from 115 countries around the world for the past 16 years, we compute statistical moments of some key indicators of the changing banking landscape in the FinTech era. Our preliminary findings suggest that it is unlikely that FinTech lenders will replace banks, perhaps because banks are developing their own FinTech platforms or working with FinTech start-ups. We also showcase how regulation, global infrastructures and geopolitical frictions will shape the future of banking. We identify some promising research ideas; we also summarize some key implications, from existing research, for policy makers and practitioners.

1. Introduction

The financial technology (FinTech) revolution is in full swing globally. Although technology has been a part of the financial services industry since the 1850s, it is only during the past two decades that FinTech has become a term to customarily describe breakthroughs in technology that potentially have the power to transform the provision of financial services, drive the creation of novel business models, applications, processes, and products, as well as lead to consumer gains (Arner, Barberis, & Buckley, 2015; Feyen, Frost, Gambacorta, Natarajan, & Saal, 2021; Sironi, 2016). During the same period, the banking sector has undergone far-reaching technological and regulatory changes, driven among others by deregulation and liberalization, advances in information and communication technologies, novel solutions for transactions and saving, changes in cybersecurity and digitisation.

Given the importance of banks in the financial system, it is critical to understand the risks and opportunities that FinTech creates for banks and its impact on the main functions of financial intermediaries as well as their role in the modern ecosystems of financial services.[1] Specifically, it is not altogether clear whether the FinTech revolution will completely disrupt traditional banking or, on the contrary, strengthen the portfolio of existing banking products. To the best of our knowledge, an overview of the existing literature on this issue has not been undertaken; this is what we aim to do in this paper. We review the burgeoning literature on FinTech and FinTech-enabled services, focusing on the opportunities and risks for banks. This paper is therefore timely because in most countries the traditional 'brick and mortar' model in banking has been combined with or replaced by an online model, where information technology and highly specialized human capital play important roles (Vives, 2019). In this setting, traditional financial institutions have been facing competition in their main business by non-banking financial institutions and shadow banks (Buchak, Matvos, Piskorski, & Seru, 2018). In addition, the emergence of FinTech has allowed start-ups, BigTech and neobanks or challenger banks to enter the financial services sector as new competitors; in particular, FinTech start-ups are active in the key segments of financial services such as payments and remittances, lending, enterprise financial management, crowdfunding, enterprise technologies for financial

* Corresponding author.
E-mail address: efthymios.rizopoulos@manchester.ac.uk (E. Rizopoulos).

[1] We refer to banks as "traditional financial institutions", switching between the two terms. Although, some of the digital banks hold a banking license and thus are classified as banks by regulation, for the purposes of this discussion they are treated as FinTech start-ups, neobanks and challenger banks thus putting them in a separate category of firms that disrupt the banking and financial services sector.

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institutions, trading and capital markets, insurance, personal financial management, wealth management and digital banking. For example, Fig. 1 depicts the breakdown for the financial services spaces in which FinTech firms and start-ups engage in Latin America. What is interesting here is that although the diffusion of FinTech is still in the early stages globally, there is potential competition with traditional financial institutions which may lead to a relative decrease in the market share of these financial institutions, implying disruption of the classical textbook view of financial intermediation in which the core activity of banks is to provide loans based on deposits from the public (Freixas & Rochet, 2008; Greenbaum, Thakor, & Boot, 2019).

An additional contribution of this paper is that it uses high quality bank level data from 115 countries around the world to compute some important indicators about the status of banking in these countries for the past 16 years in order to highlight the changing landscape of financial intermediation and the main functions of banks in the FinTech era. Using the statistical moments of the computed indicators (e.g. the weighted average of the ROA across time), we confirm that banking is changing following the different financial crises and that FinTech has an important role in this transformation of banks.

Also, an extra contribution of the paper is that it showcases how regulation, global infrastructures and geopolitical frictions will shape the future of banking. We present the FinTech narrative, the potential opportunities and risks it creates for banking; we debate the need for the digital transformation of banks and examine its driving forces. Based on the discussion, we offer some views about the future of banking and what to expect in the years to come in the financial services ecosystems.

The remainder of this paper is structured as follows. Section 2 discusses the changing landscape of banking through the prism of information and financial intermediation and the main functions of banks, provides some data analysis for the status of banking globally and explains how the current affairs can shape the future of banking. Section 3 focuses on the FinTech narrative and the digital transformation of banks. Section 4 offers a discussion about the future of banking and the opportunities for development in a modern ecosystem of financial services. Section 5 offers concluding remarks.

2. Information and financial intermediation in banking: a changing landscape

Since the beginning of financial intermediation, banking has been a pivotal function of the economic life of many progressive societies often signalling economic and financial strength, as well as societal and cultural progress. While banking has drastically evolved over time, and transitioned through many shapes and forms, economists and finance theorists commonly trace its origins in the existence of imperfections in capital markets and trade (Dewatripont & Tirole, 1994; Freixas & Rochet, 2008). Such market deficiencies are largely described by increased transaction costs and asymmetric information, which are central to the intermediation literature and exist in most economic transactions, but most importantly have been a driving factor for the establishment and increasing importance of financial institutions (Bhattacharya & Thakor, 1993; Santomero, 1984).

It is useful to put forward a short framework that will help us understand how recent developments have changed the DNA of a bank. Financial intermediaries fuel economic growth through two key functions: (i) *transforming* the "nature of claims" – for example, turning deposits into mortgages and loans, and (ii) providing a *brokerage, matchmaking*, or *transactional* service by bringing together economic agents with complementary needs – e.g. people and businesses who seek capital with those who are in excess of capital, or entities who seek intermediation for payment services. Regarding the first function around maturity transformation of assets and liabilities, banks can manage efficiently any potential disparity between the demand and supply of liquidity and the consequent implications (Drechsler, Savov, & Schnabl, 2018; Navaretti, Calzolari, Mansilla-Fernandez, & Pozzolo, 2018). The deposits are normally made of a considerable number of savers with different financial risk characteristics. According to Thakor and Udell (1991), the ability of banks to have deposits make them more trustworthy than non-banks. In a sense, banks transform short-term deposits

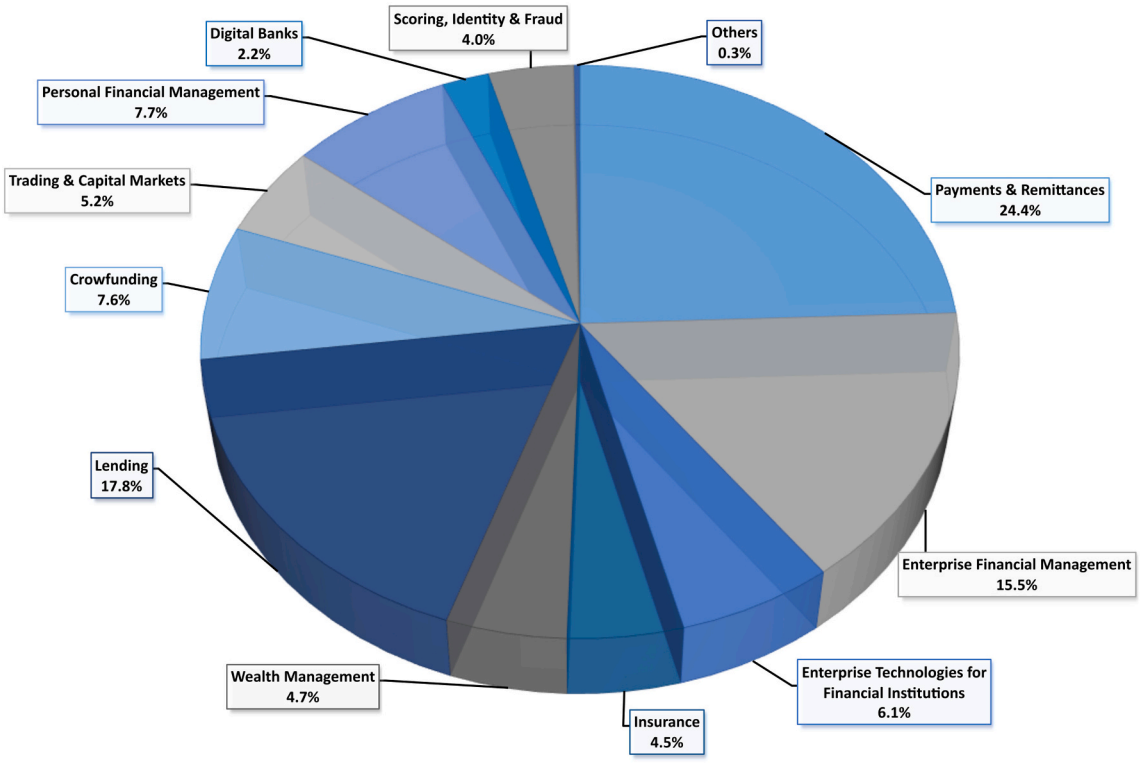

Fig. 1. Number of FinTech start-ups by financial service segments in Latin America in 2018. (Source: IDB and Finnovista (2018))

that are liquid into long-term loans, liquid or illiquid, and carry out their second key function which is the provision of liquidity (Bryant, 1980; Diamond & Dybvig, 1983, 1986). At the same time, the banks can deal with the credit risk through diversification of funding resources, priority based on seniority, capital cushions and deposit insurance (Diamond & Dybvig, 1986; Gatev & Strahan, 2006), whereas they reduce the transaction costs. On the contrary, FinTech firms without a bank license can accomplish only the initial part of this function, that of raising the necessary funds. As Navaretti et al. (2018) point out, FinTech firms are like "full-reserve or narrow banks", they can collect the funds into a pool, so that customers can have access and use them when needed, but they cannot use these funds to provide illiquid loans or obtain assets with lower liquidity. For the latter, FinTech firms would need to have a license that will allow them to act as banks. The authors also argue that FinTech companies engaging in lending are principally acting as brokers in an agency model, matching counterparties, receiving fees for their services, and transferring the credit risk associated with the loans directly to investors. Consequently, they have less diversified portfolios both for their assets and liabilities compared to banks.

Following the above, there is a voluminous literature that examines the role of banks as liquidity providers in the financial system. Diamond and Dybvig (1983, 1986), Gorton and Pennacchi (1990), Holmström and Tirole (1998), Kashyap, Rajan, and Stein (2002) and Gatev and Strahan (2006) are some representative papers in this area. The creation of liquidity through transformation is nearly exclusive to banks and allows them to grant loans to borrowers and provide liquidity services to their clients. Specifically, Navaretti et al. (2018) indicate that the supply of liquidity and risk management by banks is undeniably linked with their capacity to provide payment services. For example, liquidity needs are better met if clients can use their deposit accounts to make payments instantaneously without cash intermediation. Checks, ATMs and POS were the first "innovations" to facilitate payment services, with transactions taking place directly among banks. The provision of liquidity is the function of the banks that FinTech has principally disrupted and for which banks face most of competition. On one hand, the strict banking regulations have incited the emergence of shadow banks that gradually grew their market share in financial services spaces that do not require a banking license to be served. On the other hand, in recent years the technological developments allowed BigTech and FinTech firms to offer a variety of credit and payment solutions. There are several reasons that have contributed to this disruption. For example, in developing countries, the lack of traditional financial infrastructure or the scarcity due to geographical characteristics of certain areas make FinTech solutions the only possible way for people to access financial services. Another potential reason is the strict regulatory requirements for banks and the non-existent or favorable such requirements for other players in the specific financial spaces. In some cases, this gives also rise to regulatory arbitrage opportunities, which many FinTech firms can successfully exploit. The lower costs due to propriety technologies and the economies of scope and scale, different in nature to those of traditional financial institutions, which NBFCs, BigTech and FinTech firms could take advantage of, can be a supplementary explanation for the proliferation of FinTech in the specific spaces.

FinTech firms engaging in banking service spaces have led to a disintermediation of incumbent banks, partly benefiting from the current lenient regulation. The important question here is whether banks should treat FinTech as a challenge to their status quo and FinTech firms as competitors, or as an opportunity to extend their reach and improve the overall provision of liquidity. For example, in the lending space, Tang (2019) argues that P2P platforms can be seen overall as supplements to banks and not as a substitute. Moreover, as explained by Navaretti et al. (2018), FinTech firms cannot replace banks, but rather coexist with them, cooperate, or potentially become like banks. One of the reasons is that the liquidity that FinTech lenders provide is limited because they do not have access to central bank liquidity like banks. The fact that they cannot do maturity transformation limits further the liquidity services they can offer. In fact, there have been many cases where online lending platforms have permitted maturity mismatches, with lenders being able to take their money faster than borrowers repay their loans (Dermine, 2017). Thakor (2020) provides an in-depth overview of the differences between P2P lenders and banks (Table 1) and explains that whether P2P lenders will eventually substitute banks in the lending space depends on the regulatory and funding costs, popularity of banks among customers, provision of safety and insurance and collateral requirements. However, he concludes that eventually banks will develop their own platforms or partnerships with FinTech firms, and it is unlikely that FinTech lenders will replace banks.

In the context of transactional-based functions such as payments, indeed FinTech firms or Non-Banking Financial Institutions (NBFIs) that use FinTech solutions may have an advantage over banks, because they have the initial tech infrastructure to implement them faster and the economies of scale and scope to make them a vehicle for profitability. However, Thakor (2020) maintains that the extent at which FinTech solutions related to payments will influence banks depends on the type of the economy we consider. For instance, FinTech solutions play a vital role for payments and other related banking services in some developing counties, where financial infrastructure is scarce. Finally, DLTs and blockchain, especially in cryptocurrencies, and smart contracts are good examples where the use of technology weeds out the need of an intermediary bank that will monitor whether the transaction is legitimate or check who the owner of the asset transferred is.

For all the above functions, banking institutions are being rewarded for their service and add value by taking advantage of their unique position that allows them to process information and calculate risks. This is the reason why, by nature, banking is for the most part an *information business*. In both roles as a broker or a qualitative asset transformer, banks take advantage of their centrality to collect, process and transmit information as well as interpret signals that are not readily

Table 1
Banks vs P2P lending platforms.

Banks	P2P lending Platforms
A. Services provided	A. Services provided
• Improved risk sharing and consumption insurance	• No
• Screening	• Yes
• Monitoring	• No
• Funding liquidity creation	• No
• Loan commitments (credit rationing insurance) and other off-balance-sheet puts and guarantees	• No
B. Capital Structure	B. Capital Structure
• High leverage with little bank equity capital	• All equity-financed: no equity capital invested by lending platform, so investors are equity holders in loans
C. Incentive problems	C. Incentive problems
• Insufficient screening	• Yes
• Insufficient monitoring	• No
• Insufficient funding liquidity creation	• No
• Excessive risk-taking due to high leverage and safety nets	• No
• Overlending and excessive growth due to incentives distorted by safety nets and too little capital	• Overlending and excessive growth due to profit-maximization motives
• Insufficient capital due to safety nets	• No
• Incentives to renege on off-balance-sheet commitments	• No
D. Regulation	D. Regulation
• Deposit insurance and capital regulation	• No
• High regulatory costs and restrictions	• Lower regulatory burden
E. Objective function	E. Objective function
• Maximise bank equity value	• Maximise value of P2P platform's owners' claim consisting of origination and other fees plus fraction of borrower repayments.

Source: Thakor (2020).

available to others. In that they reuse these cross-sectional and intertemporal information to create value for their customers (Greenbaum et al., 2019). For example, banks require to process information about a customer or firm before they offer a loan, but also collect information about them after the loan is granted. Access to this kind of reusable information allows banks to take advantage of economies of scale and scope and reduce information asymmetries (e.g., coming from adverse selection or moral hazard) through credit analysis and by sorting out risks. Innovations in information and communication technologies have completely altered the way in which information is stored and processed (e.g., cloud-computing), reduced the costs of data transfers (e.g., portable devices, internet, DLTs, blockchain), increased the data availability because of digitalization (Bofondi & Gobbi, 2017). The type of information that is managed and collected by banks is an important aspect in understanding how FinTech affects this function.

In finance literature, information is customarily divided into two broad categories: hard and soft information.[2] Historically, banks have been collecting mainly soft and relationship-based information to make informed decisions about the provision of their services. This type of information constituted a competitive advantage due to the difficulty of replication and transmission outside the respective bank. Gradually, as hard information about customers became available, banks started using it instead of or in conjunction with soft information for some functions, which migrated outside the bank (Liberti & Petersen, 2019). The use of hard information over soft information is more expected in larger banks (Berger, Miller, Petersen, Rajan, & Stein, 2005; Qian, Strahan, & Yang, 2015), due to their hierarchical structure and the possible separation between those that collect information and those that make the final decision about the provision or not of a specific service or product (Stein, 2002). These banks will most likely avoid granting relationship loans, which are based on soft information. On the contrary, FinTech firms rely principally on hard standardized information, Big Data and machine learning. From Facebook likes and tweets on a specific topic to consumer behaviours and profile pictures, FinTech allows any information that can be quantified to be used for making investment decisions or assess the creditworthiness of an individual or firm. Potentially, this leads to better customisation and pricing of services and products, flexibility, screening, and matching, but also entails the risks of discrimination, privacy invasion, identity theft and fraud. New technologies also permit to some extent the partial hardening of soft information, for example the coding of text into numbers. There are several papers on this possibility including but not limited to Da, Engelberg, and Gao (2011), Dougal, Engelberg, Garcia, and Parsons (2012), Huang, Zang, and Zheng (2014) and Gentzkow, Kelly, and Taddy (2019).

The use of hard information in lending is not novel (Einav, Jenkins, & Levin, 2013), but the amount of data that can be collected, processed and used, along with the "hardening" of soft information with the use of FinTech is. However, the context is an important distinction between hard and soft information (Liberti & Petersen, 2019), especially in FinTech space. Assessing your creditworthiness based on your profile picture may be accurate only if the person depicted in that picture is you. Similarly, the number of friends you have online should be important only if it is credible. For example, Freedman and Jin (2011) find that a loan has higher return if a friend endorses the loan and lends you at the same time, but lower if the same friend just endorses the loan. The strength of the friendship is questionable; the investment of money is not. The issues between hard and soft information are also present in the financing FinTech space for MSEs, where some crowdfunding lenders prefer hard information (Liberti & Petersen, 2019). However, a crucial issue that arises is that hard information may be difficult to collect, especially for start-ups. Finally, the use of hard information to automate processes is particularly important in the investment advice space, where the collection and processing of soft information may be expensive. FinTech solutions, such as robo-advising, process past investment choices, risk aversion, and other relevant information, identify certain patterns in the data and make appropriate suggestions to investors, which may be more efficient compared to the traditional service that a bank provides.

[2] Liberti and Petersen (2019) provide an excellent analysis on the differences between these two categories.

2.1. Market transformation and competitive dynamics

While the above description is by and large a central one concerning the banking narrative world-wide, research has shown that there is much variation on the significance and role of banks across the world and across different periods in the history of the global financial system. For example, in the recent decades and mostly after the 1980s, there have been a substantial reduction in the transaction costs and information asymmetries mentioned above mainly due to the introduction of technology and shifting business demands. As it can be understood, over this period and by some measures, the significance of traditional deposit-taking banks that offer loans has been gradually reduced. Looking at various statistics, one can quickly see the changing nature of financial intermediation. Barth, Nolle, and Rice (1997) have documented the decreasing number of financial assets held by depository institutions (in relation to other financial intermediaries) in the US which fell from 60% to almost 25% between 1950 and just before 2000. This negative effect on the financial intermediation business led most banking institutions to innovate so that they respond to the competition from markets and explore avenues away from their traditional functions and into other fee-producing financial activities such as insurance, mutual funds, trusts, and transactions services (Allen & Santomero, 2001).

In order to shed more light on the status of financial intermediation and banking sector, we use bank level yearly data for commercial, savings and cooperative banks of 115 countries from Bankfocus, industry level yearly data from ECB for European credit institutions and industry level yearly data from FDIC (Federal Deposit Insurance Corporation) for US commercial banks. The data spans the period between 2005 and 2020 for most indicators and extends across different regions including Europe and Eurozone, North America and Latin America, Asia and the Pacific and Africa. To capture certain geopolitical trends, we also average the respective bank level data across the OECD countries. On a country level, our analysis is focused on ten distinct countries inter alia USA, UK, Singapore, Lithuania, Switzerland, Sweden, The Netherlands, Australia, China and India. We have specifically chosen these countries based on two FinTech criteria. First, most of them are countries that top the Global FinTech Index, a real time proprietary global database of FinTech firms created by Findexable, which demonstrates the strength of FinTech start-up ecosystems in each country (Appendix – Fig. A1). Second, most of the countries have a high adoption rate as measured by the Global FinTech Adoption Index introduced by EY (Appendix – Fig. A2). On the technical side, to avoid survivorship bias, the bank level data includes also banks that are currently inactive but used to be active in any year under investigation. We have removed banks that are currently active, but our dataset does not provide data and yearly observations that are either extreme or erroneous. We confirm that the missing data is related to smaller banks which are not expected to affect the overall trends we attempt to investigate in this paper. To account for the varying number of banks per year, either due to lack of data or due to the banks becoming inactive, we use averages for each country and year. Finally, for the regional graphs, we estimate weighted averages scaling each country of the region with the number of banks available for each year.

An important indicator for the status of the banking sector is profitability. Fig. 2 depicts the weighted averages of profit or loss of banks in our sample in major regions globally. Undoubtedly financial crises have a considerable negative impact on the performance of the banks with the global financial crisis of 2007–2009 (GFC) being a clear example for all

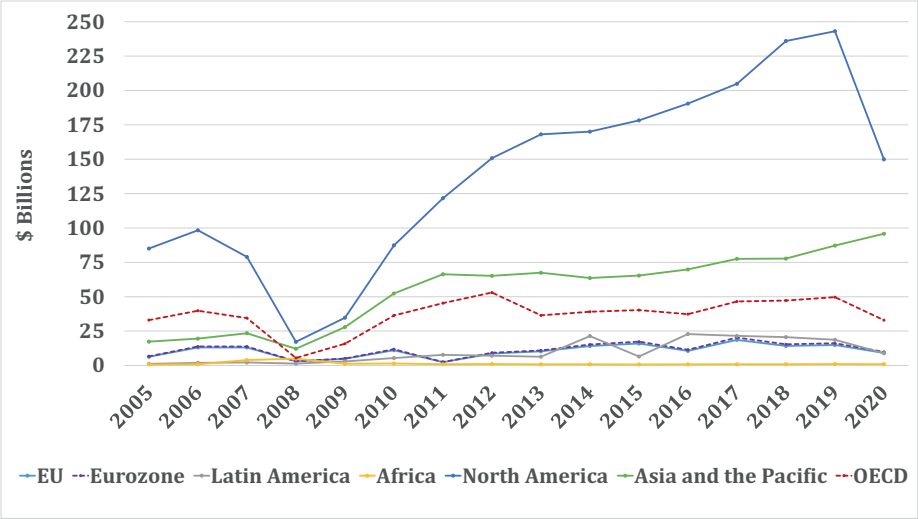

Fig. 2. Weighted average of proft/loss before tax of banks in major regions of the world. (Source: Authors' calculations using data from BankFocus, ECB, and FDIC)

major regions in the world. According to Carletti et al. (2020), the significant decrease in the profitability of banks was driven by the number of defaults, the draining of the market liquidity and the increase in risk premia of most assets. However, for eurozone the most significant decrease occurred in 2011 due to the sovereign debt crisis. In all regions, but Asia and the Pacific, we also see a decline in the period between 2019 and 2020, sharper for North America, possibly driven by retaining earnings to cover for any potential losses caused by the Covid-19 pandemic. Based on Fig. 3, in the USA and UK, Sweden, Lithuania, Switzerland, the Netherlands, the profits of banks plunged at some point during 2007–2009, but only US appears to have recovered to pre-GFC profitability levels. On the other hand, the global financial crisis did not significantly affect the banks in China, India, Singapore and Australia, but there is a decreasing trend after 2012 for most of them. Moreover, while there is a homogeneity in the profitability of banks in most countries in the pre-GFC period, the picture changes completely after 2009. Overall, in both graphs, there is an improvement of profitability for most regions and countries in the period before 2019, which according to Carletti et al. (2020), can partly be justified by the increase in the number of businesses that could generate fees and commissions for banks, the decrease in the number of non-performing loans and the considerable effort that larger banks put into their growth. Figs. A3 in Appendix confirms the negative correlation between profit/loss before taxes and non- performing loans/gross loans ratio for all ten countries in our sample. To further examine the profitability of the banking sector we plot the return on average assets (ROAA) in Fig. 4 and return on average equity (ROAE) in Fig. 5 for the same regions. Although for most regions ROAA has followed a decreasing trend that slows down after 2010, the ROAA of US banks has been significantly increased after 2009 following an upward trend until 2019. In addition, banks in Latin America have experienced an increasing ROAA that picked in 2014 to steadily decrease thereafter. Similar is the picture for the ROAE of banks, with North American banks having a significant increase after 2009, bringing them along with the banks in Africa and Latin America among those with the highest ROAA on average (9%–10%) in 2020. We see similar trends when we plot the average ROAA and ROAE, with Lithuania and UK banks experiencing negative percentages in the period around 2009 (Figs. A4 and A5, Appendix).

Apart from profitability another important indicator for the status of the banking sector is the value of deposits that banks around the world have accumulated during the period under analysis. With the emergence of FinTech and digital banks someone would expect to see a drop in this value. Upon inspection of Fig. 6, it is apparent that on average this is not the case for the different regions around the world and particularly for the banks in North America. Although there is a slight drop in the average value of deposits after 2011 in most regions, the trend remains upward. Given the way we have estimated the weighted averages for the value of deposits, the trend depicted in the graph above is mainly driven by those countries in each region where the banking systems have larger banks that continue to grow and are not affected yet by new competition. At the same time, this trend may be partly affected by the decreasing number of active banks over the period under analysis. Another interesting observation is that even though it is well document that customers lost faith in banks after the global financial crisis, apparently, they still trust them with their money on average. We discuss more about this “industry paradox” in Section 3. Nevertheless, when we look the value of deposits in a country level, the picture is different. Specifically, as shown in Fig. 7, almost in all countries in our sample the value of deposits increases at the earlier years of the period under investigation and follows a gradual decrease until 2013, when it starts rising again. Lithuania, one of the most important FinTech hubs in Europe, where many FinTechs have acquired their banking license, is a good example of this. The two countries where the value of deposits does not experience a significant drop overall are China and Singapore, the first known for the government interventions in the banking sector and the second one of largest FinTech hubs in Asia with a track record of granting digital banking licenses. Currently, there is no dataset available with this type of information about FinTechs so that we could investigate any potential connection between the increase in deposits in some countries and the presence of FinTech's in the local banking sector. This however can be an interesting topic for future research.

Continuing the analysis of the global banking sector, the financial literature has well documented that the market structure can potentially influence its profitability. For example, Carletti et al. (2020) argues that the profitability of the banking sector in the US is higher than the European sector because the former is more concentrated (six largest banks own 60% of total assets), while the later is fragmented (six largest banks own 30% of total assets). In addition, there is a popular view among market participants and industry experts that the cost-to-income ratio and market concentration are negatively correlated, which under certain conditions may indicate greater welfare for customers. Fig. 8 presents the market concentration of the banking sector as measured by the Herfindahl–Hirschman Index (HHI), a commonly accepted measure of market concentration, which ranges from close to 0 to 10,000, and groups markets into 3 groups: a) low concentration for HHI $<$ 1500, b) moderate concentration for 1500 $<$ HHI $<$ 2500, c) high concentration for HHI $>$ 2500. In all regions market concentration as measured by HHI reduces overtime after 2007 and has an upward trend after 2019. This

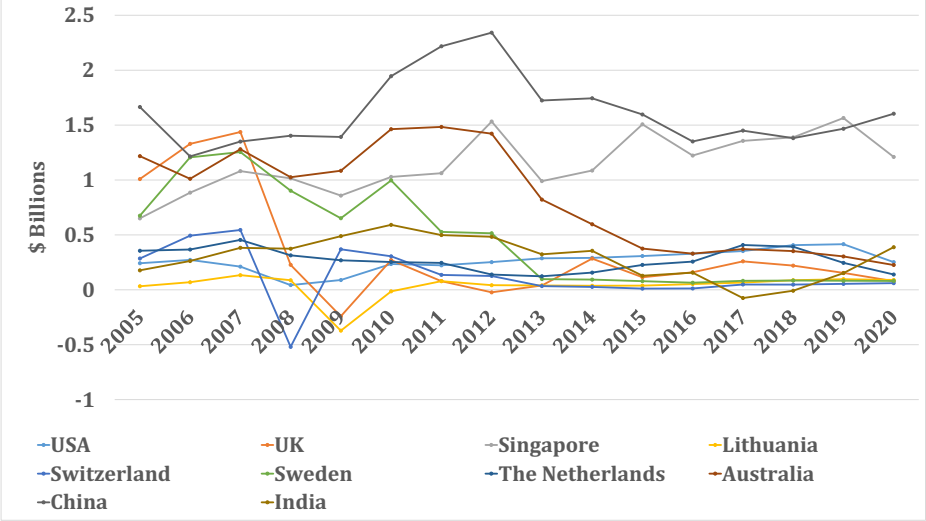

Fig. 3. Average of profit/loss of banks in countries with strong FinTech ecosystems. (Source: Authors' calculations based on data from BankFocus, ECB, and FDIC.)

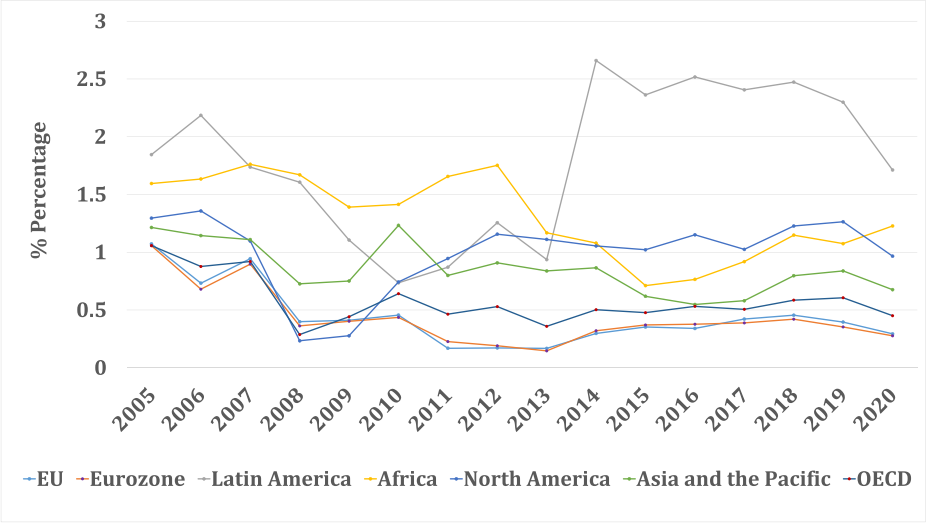

Fig. 4. Weighted average estimates of ROAA of banks in major regions of the world. (Source: Authors' computations based on data from BankFocus, ECB, and FDIC)

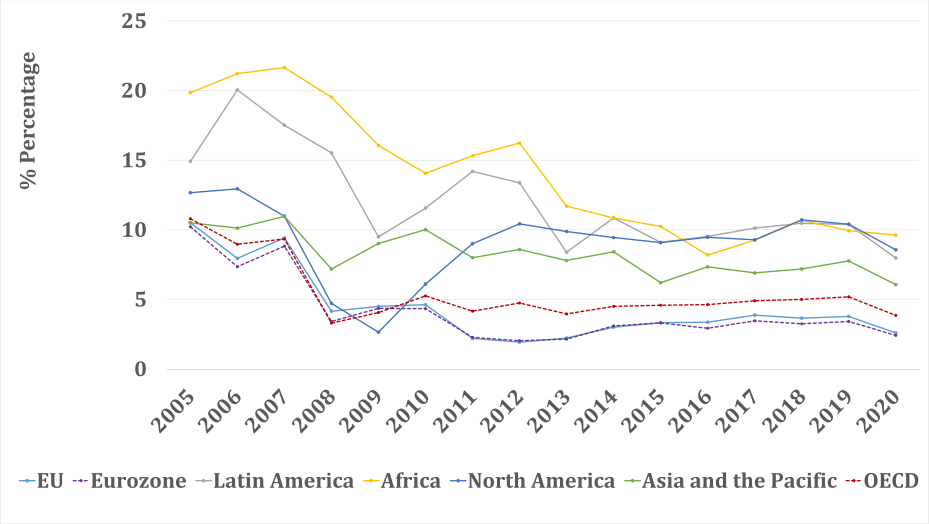

Fig. 5. Weighted averages of ROAE of banks in major regions of the world. (Source: Authors' computations based on data from BankFocus, ECB, and FDIC.)

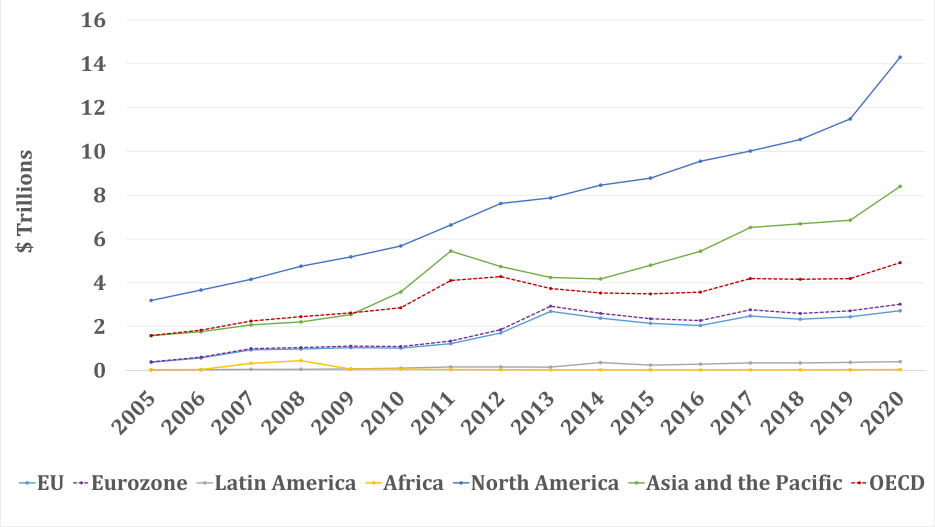

Fig. 6. Weighted average of the value deposits of banks in major regions of the world. (Source: Authors' computations based on data from BankFocus, ECB, and FDIC.)

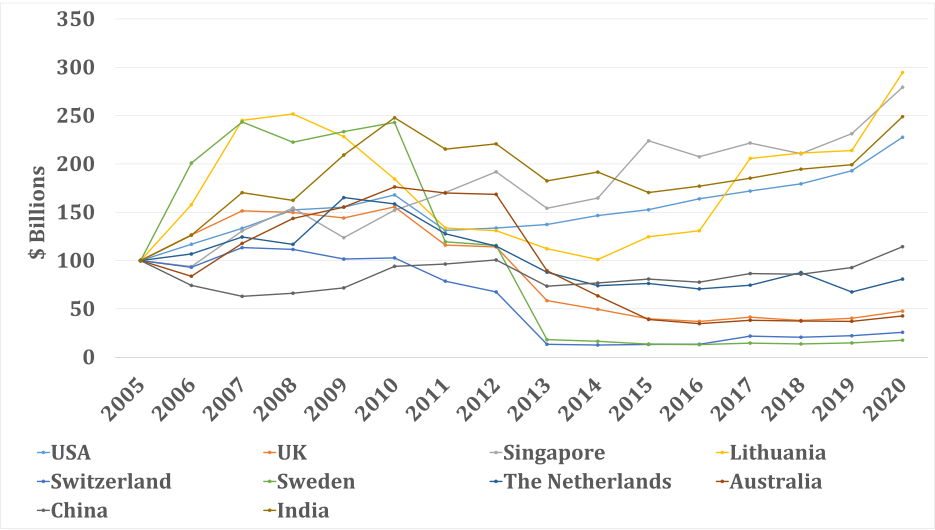

Fig. 7. Value deposits of banks in countries with strong FinTech ecosystems (2005 = 100). (Source: Authors' computations based on data from BankFocus, ECB, and FDIC)

trend can partly be explained by the fact that HHI considers the market shares of all banks in the market and there is an increase in their number over the years, something that directly affects the estimated averages. The decreasing trend is similar when we look at the HHI on a country level, with all countries except USA, UK, China and India, having high market concentration. In addition, Lithuania and Switzerland are countries with the highest increase in market concentration from 2018 onwards. (Appendix – Fig. A6).

To further investigate the market concertation of the banking sector, we calculate the market share of the three largest banks in each of the ten countries with the strongest FinTech ecosystems. The results are similar when we choose the 5 largest banks instead. Fig. A7 in the Appendix shows the same trend as we have previously described. Specifically, the market share of the largest banks has been gradually decreasing for most countries until 2019. However, this trend reverses after this year, in a sense indicating an effort of the banking sector to gradually consolidate especially after the impact of the Covid-19 pandemic. This result maybe be driven by the fact that the number and value of M&A in the banking sector has been dropping in the past decade, while FinTechs enter the market and gradually acquiring a banking license. It is also interesting to investigate whether a higher market concentration is correlated with a lower cost-to-income ratio and consequently with higher efficiency. We proceed by estimating the average HHI and cost-to-income ratio for 115 countries around the world. Fig. 9 presents the scatterplot of cost-to-income ratio versus market concentration as measure by the HHI.

First, on average there is a significant disparity in terms of concentration across different counties. Second, there is an obvious negative correlation between market concentration and cost-to-income ratio. However, this does not necessarily suggest causality. Indeed, higher market concentration can potentially lead in the generation of economies of scale and scope, but it can also lead to an increased market power. The first is associated with a decrease in costs (and an increase in efficiency), which ceteris paribus leads to a decrease in the cost-to-income ratio and the second with an increase in income, which ceteris paribus leads also to a decrease in the ratio. It is only in the first case that a greater social welfare in generated. This is something important for the policy makers to consider in the post-Covid-19 Fintech driven world,

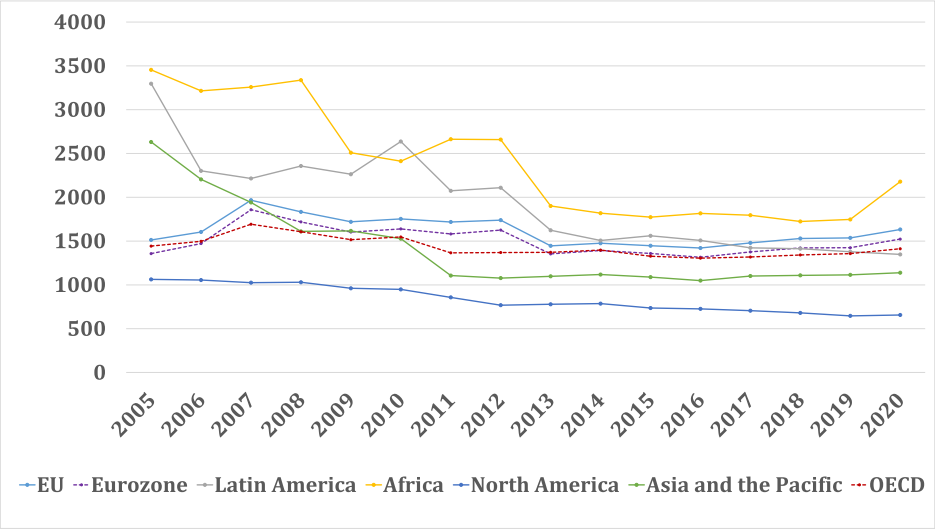

Fig. 8. Weighted average of HHI based on all banks in the market in major regions. (Source: Authors' computations based on data from BankFocus, ECB, and FDIC)

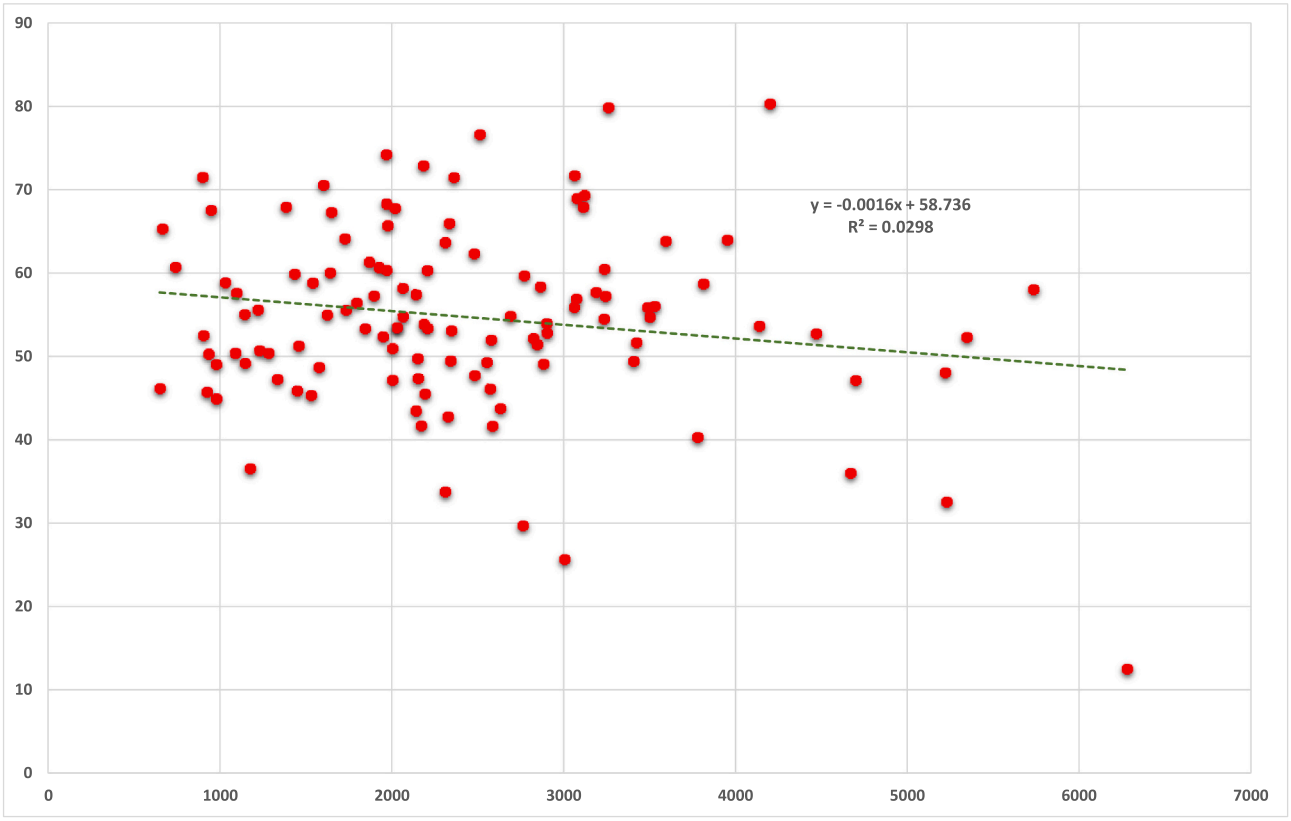

Fig. 9. Cost-to-income ratio vs Market Concentration (Averages). (Source: Authors' computations based on data from BankFocus, ECB, and FDIC)

where market concentration might be the key for some banking sectors to preserve stability and efficiency.

Part of the banking market transformation is the gradual disentanglement from the traditional brick-and-mortar business model to a digital one. The reasons for this are different between developing and developed countries mainly because in the former it was not a choice, but rather a necessity. Fig. 10 shows the change in the number of branches for Europe and Eurozone, UK, USA, Lithuania, Sweden, and the Netherlands. Unfortunately, our dataset does not provide this information for the remaining 5 countries under investigation. The figure presents a clear decreasing trend in the number of branches, which is sharper for the Netherlands, Lithuania, and UK with a drop of more than 40% in the period between 2003 and 2020. Although this trend captures dissolutions it may also indicate a movement towards a more digital model whereby customers can receive banking services anywhere and not only in a branch.

Moving forward, extant studies looking at the corporate scope of bank holding companies have shown how over the past 30 years there has been a significant increase of bank assets devoted to non-bank firms, thus, expanding drastically the range of banks' activities – at times beyond the financial services sector – and even questioning the very definition of what a bank is or does (Cetorelli, Jacobides, & Stern, 2017;

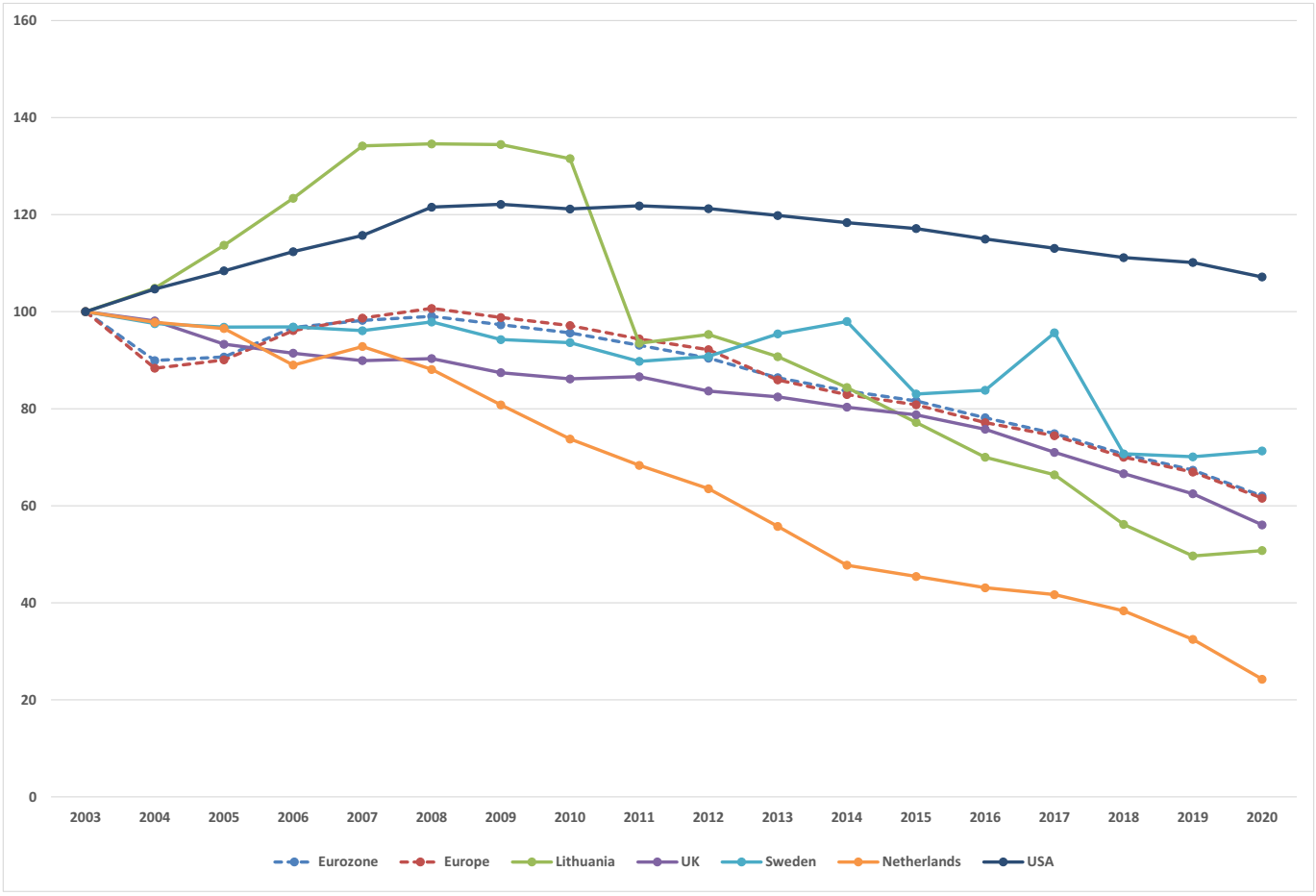

Fig. 10. Number of branches (2003 = 100). (Source: Authors' computations based on data from BankFocus, ECB, and FDIC)

Liang & Savage, 1990). Such diversification has had a significant effect on the business models of banks, but also the overall market structure of the sector as businesses were seeking better gains depending on their knowledge base, capabilities, and appetite for risk. Relevant research has shown that as certain sub-markets matured and transaction costs further diminished through information standardization and simplification of coordination, financial intermediaries were better off vertically dis-integrating and specializing in one part of a production process. This was particularly the case when, during the 1970s and thereafter, vertical dis-integration in mortgage banking broke up the mortgage value chain (e.g., separated origination, holding the loan, servicing, brokerage, warehousing, and credit risk) and led to the emergence of new intermediate markets, where novel types of specialized firms changed the industry's competitive landscape (Jacobides, 2005). By strategically positioning themselves and expanding their scope or specializing and innovating in certain markets, banks have managed to remain an important part of the financial system.

To investigate these ideas, we have collected data regarding the investments in FinTech start-ups and scaleups of the six largest banks/bank holding companies in UK (Barclays, HCBC, Standard Chartered, Lloyds Banking Group, NatWest, Royal Bank of Scotland) in the last decade. Fig. 11 depicts in percentages the breakdown of the investments across different FinTech spaces (for more detalied infromation please refer to Appendix - Table A1). Barclays and NatWest/RBS combined are the two banks that lead the FinTech investments in UK, with most of them concentrated in start-ups and scaleups that engage in payments and banking spaces, followed closely by financial management solutions. All these three spaces account for approximately 65% of the FinTech investments in UK coming from these six banks. Given that these spaces are the ones in which banks currently face most of the competition, their focus on them highlights in a sense an effort to increase their digital capabilities in the specific spaces, by acquiring or investing in FinTechs that offer propriety solutions. Another interesting fact is that the investment in mortgages and lending as well as wealth management spaces lags payments, banking, and financial solutions spaces. We believe that this may be driven by the fact that these traditional financial institutions have still the competitive advantage in the specific spaces due to the maturity transformation ability and/or prefer the in-house development of technology solutions that may enhance their digitalisation process. Finally, we believe that spaces like RegTech, Crypto and DeFi, Insurance and Trading will attract more investments from banks as they gradually become more relevant for their business model.

As documented in many other industries, equally in banking, market transformation can be a rather invisible part of the industry evolution, yet still manage to fundamentally transform the market structure and competition in the sector. Nonetheless, it is not only the shifting competitive landscape and advances in financial innovation that are responsible for the dramatic change of the banking industry the last few decades. The increased regulatory pressure, technological progress, changing customer preferences, as well as the recent “great recession” and geopolitical frictions, all contributed significantly to the transformation of the banking business. In the following sections, we briefly discuss these primary forces of change before we go on to project how the current affairs will shape the bank of the future in the next decade or so.

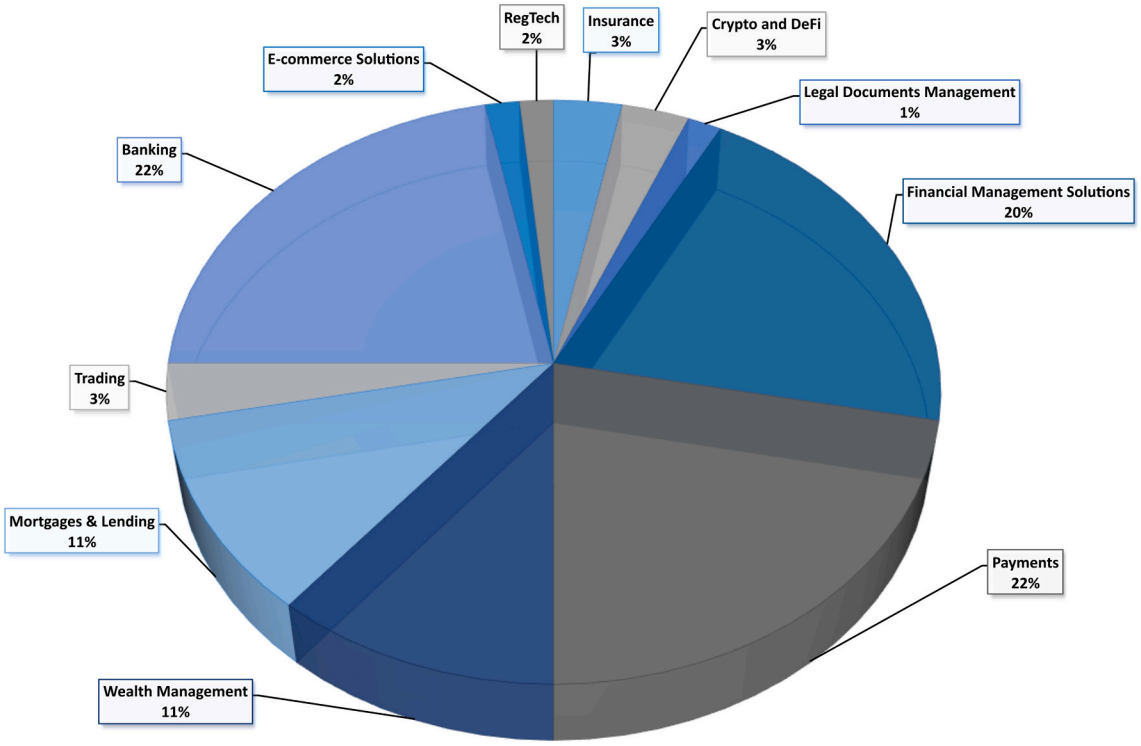

Fig. 11. UK Banks' Investment in FinTech Spaces. Source: https://datacommons.technation.io/, Authors' Calculations

2.2. Regulatory pressures

Banking is one of the most heavily regulated industries in the world of commerce, accumulating decades of regulatory interventions, supervisory efforts, and government assurances, to warrant that the financial intermediaries operating within this context can be trusted to safeguard people's money. In a sense, such regulatory frameworks are part of the "legacy infrastructure" in banking and what makes banks an integral part of every country's economy. Nevertheless, heavy regulation can also limit the banks' ability to innovate and/or be profitable amid intense competition. This is because, the purpose of regulation in financial services usually seeks to satisfy different agendas, thus can be contradictory. From one hand the regulators need to ensure consumer protection and the stability and integrity of the market, whereas, on the other hand, they need to maintain competition. These distinctive aspects of regulation can often be in conflict and mostly at the expense of competition, since strict regulation to ensure adequate protection of consumers frequently produces high-entry costs and lack of innovation due to decreasing incentives. Statistics from OECD (2017) report that in 2016 while the finance industry accounted for 6% of the global GDP, financial institutions spent less than 1.5% of the global R&D investment. Striking the right balance can be challenging but necessary.

After multiple years of rapid deregulation – from 1980s onwards – and "loose" monetary policy (mainly across the United States and Western Europe) that led to the financial crisis of 2007–2009,[3] regulators sought to tighten their grip on financial institutions in order to protect consumers and investors' wealth. Legislations, such as the Dodd-Frank Act in the US and later MIFID II in the EU, aimed at stabilizing the markets and increase transparency and accountability by commoditizing certain financial products. Increased financial reporting is also key in this context forcing financial intermediaries to disclose their fees and provide users with better information to evaluate services. While increased information will lead to a more efficient market it will also create a more competitive environment for banks who will compete in costs-effectiveness and better pricing to attract customers.

The last decade following the "Great Depression", regulation has become more both intense and more frequent. The *interconnectedness* of global markets and the speed and severity with which shocks in one part of the financial system were transmitted to other parts during the financial crisis, demonstrated the significance of *global systemic risk* (Greenbaum et al., 2019). As a result, more and better measures were implemented to enhance banks and financial markets' resilience and create higher capital and liquidity buffers. Substantial reforms in the securities and money markets as well as regulations around clearing of financial instruments, hedge funds, and credit-rating agencies also helped to build a reliable financial framework for investors and the public.

[3] While politics and flexible legislative initiatives are not the only ones to blame for the Great Recession, they played a significant role in planting the seeds of the crisis. Increasing economic and wealth inequalities as well as the relaxation of underwriting standards that led to riskier mortgage lending and consequently to the housing price bubble of 2007, which eventually burst in August of the same year. Other factors such as the increasing securitization and the originate-to-distribute model in the mortgage market, the explosion of new and innovative products such as asset-backed securities, and misaligned incentives in the market have also contributed significantly to the severe outcomes of the crisis that began in the US and kick-started a domino effect across the global financial market affecting eventually real economies across the world.

It is evident that global coordination between regulators and consultation with market participants was and still is necessary to assess the effectiveness of new laws and avoid future challenges (WEF, 2018).

But the increasing complexity and demands of regulatory frameworks are not easy for anyone. Complying with gradually intrusive regulations is a huge burden for banks which often allocate substantial amounts of capital (both in labour resources and technology) to relax those requirements and occasionally pay fines when not able to comply. Since the 2007–2008 financial crisis and up to 2017, banks have paid more than $321 billion in penalties (CB Insights, 2017) making regulatory compliance one of the top priorities in the sector. Additional regulatory initiatives such as EMIR, MiFID II, MIFIR, PSD2, and GDPR in the European Union[4] and the Fiduciary Rule, Dodd-Frank Act and CAT in the United States (in addition to global frameworks like Basel III) that came into effect after 2017 make things even more challenging for FIs. Investment in regulatory technologies from large banks has experienced strong growth the last few years with more than $5 billion funnelled to RegTech startups since 2012 to address issues across the entire spectrum of regulatory demands: from transaction reporting and data aggregation to financial crime and monitoring and detecting fraud (Gromek, Teigland, Siri, & Puertas, 2018).

At the same time regulators also strive to keep up with the complexity of the sector especially when dealing with recent technological advancements, such as blockchain and distributed-ledger technologies, artificial intelligence (AI), open APIs, cloud computing, and others. Although technological disruption is not new for regulators, the speed of innovation and the influence of FinTech on financial activities has increased since the global financial crisis (Taylor, Almansi, & Ferrari, 2020). The current dilemma for regulation is to find the balance between the maximization of benefits that FinTech innovations offer and the protection of the financial system and customers from the potential underlying risks that these innovations entail (Appaya & Gradstein, 2020). However, this is a stringent task for regulators because challenges posed by FinTech surpass the existing capacity of financial authorities, whereas the speed of technological innovations makes their timely response difficult (Ehrentraud, Ocampo, Garzoni, & Piccolo, 2020). In addition, these technological innovations may present challenges particularly when it comes to maintaining transparency and traceability. For example, in a fully automated world where AI applications and the use of data are ubiquitous, how will financial regulation and conduct address biases and limited "explainability" or black-boxed performance in algorithms?

At present, the fragmented and decentralised character of the FinTech industry makes the identification of relevant players more difficult (e.g. in crypto space) and fosters regulatory ambiguity (Magnuson, 2018). Simultaneously, it may facilitate the diffusion of adverse shocks like those caused by hacking (Chiu, 2016) or decision-making algorithms. For instance, it is well documented that HFTs can potentially contribute to market instability especially during turmoil (Jain, Jain, & McInish, 2016), such as the *E*-Mini S&P 500 Flash Crash in 2010 (Kirilenko, Kyle, Samadi, & Tuzun, 2017). The consequent potential macroeconomic domino effect of such applications is a major concern for financial regulation and conduct. Finally, another difficulty for regulators in relation to FinTech stems from the respective applications on the stability of the financial system. Despite the prevailing assumption in the literature of financial regulation that "too big to fail" financial institutions are the principal source of systemic risk, smaller firms with decentralised business models and novel technologies can also create systemic issues (Magnuson, 2018). Although, this type of business models has an imbedded efficiency, it lacks diversification, which in turn can left it exposed to unexpected adverse shocks leading to a considerable decrease in wealth. This should be particularly crucial for regulators when considering applications by FinTech firms for a banking license.

The above challenges become more significant because of the entry of BigTech companies in the financial services sector, given their market power, customer reach and technological advantage. The size of the market, the large number of market participants, the disruptive and "winner-take-all" character contribute further to existing difficulties for regulators (Magnuson, 2018). Regulation for the future financial system will need to tackle such questions and challenges, and where possible use technology not only to safeguard consumers and ensure market stability, but also for the positive potential of the global economy.

2.3. The changing world-order: global infrastructures and geopolitical frictions

Following the first wave of globalization (1850–1913) which brought a significant increase in international trade and the establishment of international correspondent banking (Panza & Merrett, 2019), post-war era saw an unprecedented increase in international financial flows and the significant expansion of transnational banks (TNBs). During that time, which Harvard historian Geoffrey Jones has termed as the "Second Globalization", international trade was reignited with commercial organizations outgrowing domestic markets and searching for opportunities to expand abroad (Jones, 2007). In that context, large organizations with international ambitions felt the pressure to converge and rationalize their processes, codify professional practices, harmonize rules, and clarify their governance. Similarly, the lack of reliable, standardized, and efficient financial telecommunications infrastructures soon became apparent. The founding of SWIFT from a relatively small group of multinational banks quickly filled that gap and served as steppingstone for banks, enabling them to engage between them safely (Scott & Zachariadis, 2012, 2014). This move was one of the most significant examples in the history of finance where banking institutions came together to share knowledge resources, set standards, and create an infrastructure for the entire industry. Since its launch, SWIFT has grown to a 10,000-member network that moves more than $7 trillion daily and has become a powerful agent and systemically important part of the global financial system that reinforces "global economic order" – a development that Leibler (2019) has termed as "infrastructural globalism".

Throughout the history of SWIFT, two notable incidents: (i) US access to SWIFT data via their Terrorist Finance Tracking Program (TFTP) and (ii) the exclusion of Iranian institutions due to the country's nuclear activities, exhibited that in spite of the hyper-connectedness of financial markets and calls for a collaborative global financial community, conflicting national economic interests can create tensions that may lead to dis-integration and distrust between participants of the global financial infrastructure which is struggling to remain neutral. Such conflicts and geopolitical pressures are more evident than ever in the current era where widespread insecurity and frustration, has led to the rise of populism among many contemporary societies (Schwab, 2018). One of the key questions debated in this context is the global-governance architecture in financial services and beyond and the calls to restore national sovereignty at a time when more cooperation is needed for the nations' economic, cultural and societal development. These developments may be a call for banks and financial infrastructures to rethink their international offerings and redesign their architecture considering the development of local configurations on top of global platforms.

This is all happening at the same time when the Fourth Industrial Revolution (4IR) is believed to bring unprecedented changes in the way we live, work, and connect to one another. Dealing with technological developments, such as AI, that will need international coordination and

[4] Acronyms stand for: European Market Infrastructure Regulation (EMIR), Markets in Financial Instruments Directive II (MiFID II), the Markets in Financial Instruments Regulation (MIFIR), revised Payment Services Directive (PSD2), General Data Protection Regulation (GDPR), and Consolidated Audit Trail (CAT).

agreements to raise standards and security protocols, protectionism and nationalist politics will not benefit this process and may potentially lead to suboptimal and risky outcomes. It is ironic to think that in an era where modern technologies are engineered to cross boundaries and function on a global and distributed basis, societies and economies raise ideological and political barriers. Such paradigm can also be traced in the world of currency and payments. Cultural anthropologist, Bill Maurer, discusses how recent geopolitical turmoil has put the spotlight on the "politics of payments". He states that, like money, "payments are political in that they are a function of state sovereignty" (Maurer, 2020). Indeed, payment data can be used as a means of state surveillance or exploited to enforce or "silence" a political conviction or agenda. Digital and mobile payments exacerbate such possibilities as the emergence of the "cashless society" obviates privacy of cash transactions and generates vast quantities of data in its wake. As a response to state dominance and "data capitalism", various social movements and activist groups have tried to introduce new forms of currencies and infrastructures or "rails" independent of centralized control. Such initiatives are what gave birth to cryptocurrencies like Bitcoin and made technologies such as blockchain popular.

3. The rise of FinTech and the path to digital transformation

Traditionally, the financial services industry has been one of the heaviest spenders when it comes to information technology (IT). During the 1960s banks were some of the first organizations that sought to deploy mainframe computers to mechanise record-keeping and reduce paper for a multitude of transactions (Bátiz-Lazo & Altés, 2011). Thirty years on, when personal computers became the norm and software engineering offered numerous applications to institutional users, investments in general purpose technologies grew further aiming at increasing operational efficiencies and cutting costs. Until very recently, banks launched massive IT projects to fully digitize their records and automate further their operations achieving faster and cheaper services for their customers. However, technology investments of this nature did little to radically re-think value chains across the various service lines and re-design products to correspond with the age of digital.

In this context, it is important to make a useful distinction that is used both in the academic literature and among practitioners. The difference between *digitization* and *digitalization* is that the former focuses more on the effort to digitize existing processes and tasks (i.e. the move from analog to digital or from a paper-based system to a digital representation of the same data or tasks), while the later signifies predominately "a sociotechnical process" and move to a digitally-native way of engaging in economic activity that suggests new ways of creating value and the adoption of novel business models (Tilson, Lyytinen, & Sørensen, 2010). In other words, digitalization includes the "broader individual, organizational, and societal contexts" (Legner et al., 2017, p. 301), and often implies a more customer-oriented inclination to problem-solving and engaging with people to address particular needs.

Considering the above, one of the biggest issues that banks are currently facing is their own legacy. Most of the technologies, business processes, and "institutional logics" currently in place are grounded in the age of the industrial revolution when cash, cheques and paper-based procedures were the norm. During that time banks designed their products and services to correspond to the needs of their corporate and retail customers of the day. In addition to that, as the demands for different products emerged deposit-taking financial intermediaries kept adding product offerings to satisfy demand. This led to a product-oriented organizational and technological structure creating silos of information that were not easily usable to provide a holistic picture of customers and their changing demands. As it can be understood, providing a digitized version of the extant setting and tolerating a fragmented information architecture will do little to keep banks competitive especially towards technology companies and large institutions from the telecommunication and other industries (i.e., BigTechs) who are seeking to take advantage and enter parts of the finance industry (Shin, 2019.).

3.1. Technological disruption and the FinTech narrative

It is an irrefutable fact that the pace of innovation and rise of digital technologies the last few years has been unprecedented. Breakthroughs in technologies such as cloud computing, mobile devices (e.g., smartphones), and sensor systems (e.g., internet of things), and the "digitization of just about everything" (McAfee & Brynjolfsson, 2016: p. 65), have enriched the availability of data from economic transactions and human interactions experienced through the internet and online platforms. The rise of machines with capabilities to collect and analyse vast amounts of data has given new meaning to algorithmic processing (e.g., use of machine learning and neural networks), which can now come closer to the potential of autonomous smart agents and artificial intelligence. Such developments had a substantial impact on many industries (e.g., music, education, transportation, hospitality, food, etc.) that resulted into the appearance of new entrants, which took advantage of those digital technologies to "disrupt" outdated value chains and redefine existing markets. A good example from the music industry is how entirely new platforms selling digital music and subscription services (e.g., Apple and Spotify) replaced long-lasting music industry players that operated physical record shops (e.g., HMV and Virgin Megastores). It goes without saying that financial services industry has also been caught up to this technological disruption that led to the emergence of the FinTech movement.

While FinTech as a word is an abbreviation of "financial technology", it is most often used to refer to the advent of technology start-ups and new entrants whose ecosystem innovates at the heart or on the fringes of financial services and provides solutions that can benefit consumers (and financial institutions) to better handle money and their finances. Taking advantage of existing technological developments, FinTech contributes to the financial ecosystem by offering novel solutions which address the current gaps in the provision of financial services. In doing so, it has the potential to satisfy more efficiently and inclusively the needs of economic agents. However, the impact of each technological development on the creation of a solution may be different for each respective need (Fig. 12).

The key difference between "traditional" investments in financial technologies and "new" ways of introducing technology in finance is that older technology implementations mainly focused on creating more cost-effective operations and achieving efficiencies through automation, while the "new" FinTech is geared more towards rethinking entire business processes and introducing new business models in finance. Popular commentators in this space, such as Chris Skinner, have described FinTech as the "R&D function of financial services in the digital world".[5] Another key characteristic of the recent FinTech wave has been the particular attention entrepreneurs and investors outside financial services (and mostly from the tech world), have given in the finance industry to take advantage of existing inefficiencies and 'disrupt' the status quo (Zachariadis, 2020).

In parallel to the above, banks have also been challenged by the shifting preferences and demographics of consumers who are becoming more technologically affluent and have as their benchmark the experiences and offerings they enjoy from other high-tech companies such as UBER, Google, Spotify, Amazon, Apple, Alibaba, Tencent, Facebook, Airbnb, and others. Many, but not all, of these organizations and technologies initially appeared or flourished soon after the financial crisis when the confidence and trust levels of consumers towards financial

[5] see full blog here: https://thefinanser.com/2015/01/ghgh.html/

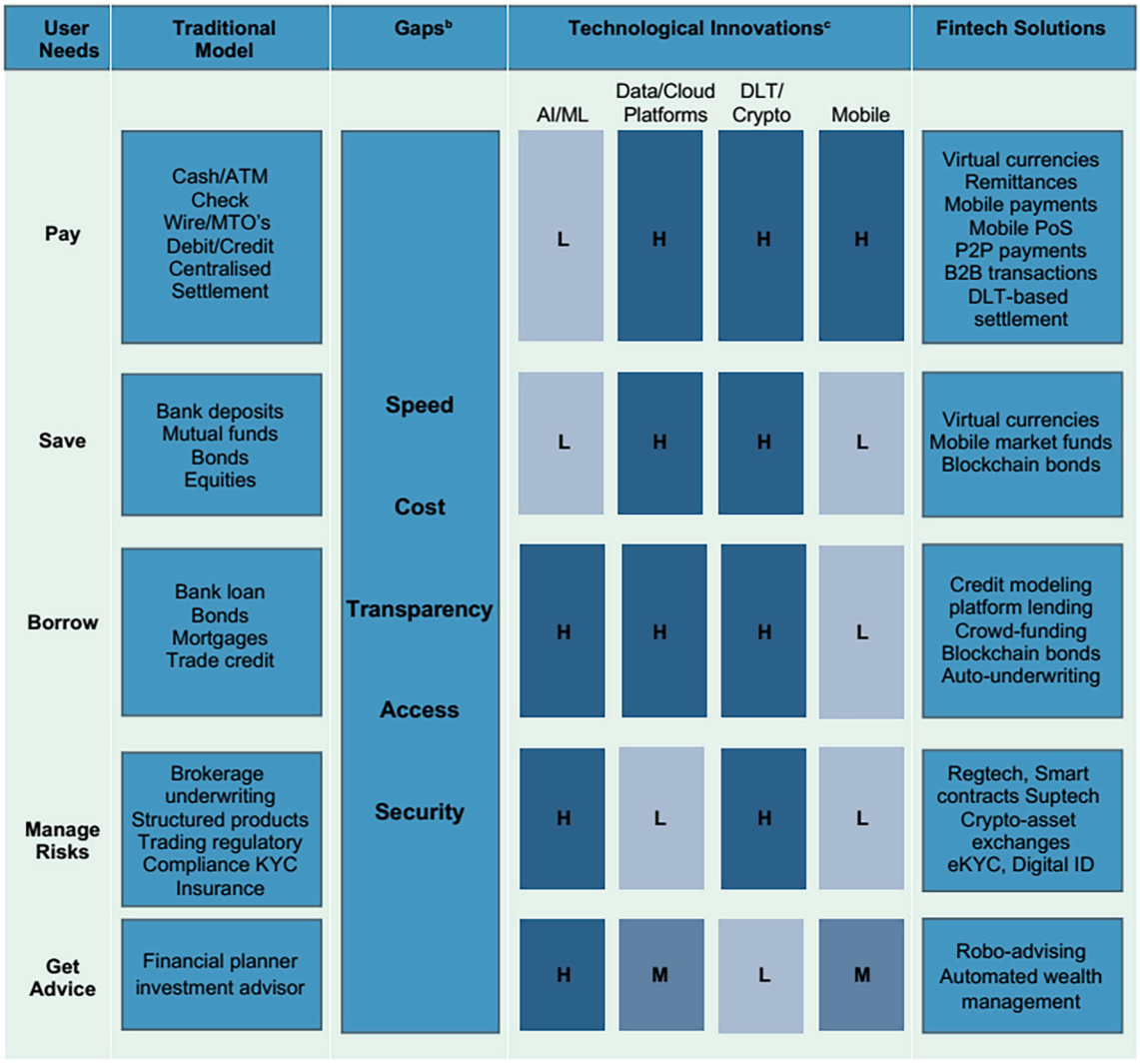

Fig. 12. Evolution of Financial Services Source: IMF (2019).

institutions were at a record low.[6] This trust deficit and the higher expectations of consumers provided some competitive advantage to FinTech startups (including newly established digital banks, neobanks or challenger banks) who continue to appear to the public eye as a "fresh start" in banking services and promise better, cheaper, and more inclusive products. Despite this, banks in many parts of the world are still occupying a significant market share and statistics have shown that consumers tend to be "stickier" when it comes to moving bank accounts and using new (and less well-known) services by alternative providers (Navaretti et al., 2018). This highlights an "industry paradox" where consumers have, for the most part, lost confidence in the banks, but are still happy to trust them with their money.

While the FinTech sector hasn't gone through significant consolidation yet, mainly due to ample VC (and other) funding still available at large FinTech hubs such as London, New York, Hong Kong, and Singapore, many founders and CEOs of startups have reconsidered their competitive stance towards larger banks and incumbent financial institutions. The current paradigm in the industry dictates that both FinTech startups and incumbent financial institutions have yet to benefit from collaborating. Given that FinTech shares similar characteristics with technological changes that occurred in previous decades,[7] it can potentially provide incumbent banks with valuable and innovative solutions to their product stack and keep their customers happy. At the same time, it can boost the efficiency and speed, in the provision of financial services, as well as reduce the cost of intermediation. Apart from the in-house development of FinTech products, which can be costly, complex, and time-consuming for the banks (EY, 2019), any interaction between banks and FinTech firms should not be seen as a zero-sum game, in which one needs to win and the other needs to lose. It is the complementarity of this interaction that can create considerable opportunities for banks, as well as FinTech firms. Specifically, banks will be incentivised to have a forward integration and FinTech firms will need to implement a backwards integration (Aaron, Rivadeneyra, & Sohal, 2017). On one hand, banks can offer stability, financial solvency, personal relationship with customers, access to a considerable customer base, variety of products and services, and financial expertise. On the other hand, FinTech firms can contribute with their big data capabilities, technological expertise, enhanced user experience and novel platforms. This synergy can potentially be beneficial not only for banks and FinTech companies, but also for their customers. According to Najaf,

[6] See Edelman Global Trust Barometer in financial services (2019). Retrieved from: https://www.edelman.com/sites/g/files/aatuss191/files/2019-04/2019_Edelman_Trust_Barometer_Financial_Services_Report_1.pdf

[7] See, for example, Goetzmann and Rouwenhorst (2005) for more on this.

Mostafiz, and Najaf (2021), this alliance between banks and FinTechs can be profitable and sustainable only if they collaborate to alleviate the underlying high level cybersecurity risks.

If the banks decide to engage with FinTech, they can do it in one of the following main ways (EY, 2019): a) Investment, where banks invest part of their own capital to a FinTech start-up, either as a VC, through a VC or direct investment; b) Collaboration, where banks for example use platforms developed by a FinTech firm or provide the network where new technological solutions can be tested and implemented or enter a joint venture with a FinTech firm or refer some of their customer to a FinTech firm for a specific financial service; c) In-house development of products where banks themselves develop FinTech solutions such contactless payments, robo-advisors for investment and others; d) M&A, where banks acquire a FinTech firm to get a faster access to new technologies; e) FinTech programs where banks either join with other banks and stakeholders a specific program with a goal to develop a FinTech solution or lead such a program. All these different ways of engagement have advantages and disadvantages depending on many factors, inter alia the existing regulatory framework, the readiness of the bank in terms of new technologies, the available FinTech solutions, the required capital, and the broad economic and financial conditions, as indicated in Appendix Table A2.

3.2. The need for digital transformation when facing shifting competition

In this new financial services landscape, banks have basically three alternatives: do nothing, knowing that most FinTech firms now aim to serve these market segments that banks do not want or cannot serve; implement FinTech technologies or cooperate with FinTech companies with an aim to improve the provision of their services and extend their market share; perceive them as competitors and attempt to prevent their entry in the market or refuse to accommodate them (Navaretti et al., 2018). The direction that the banking sector will take is still an open question, but it clearly depends on the strategies and priorities of the market players, as well as the existence of synergies that could lead to an increase in profitability, improvement of financial services and betterment of social welfare and economy. Irrespectively of how the banks will decide to engage with FinTech firms, the COVID-19 pandemic clearly showed that the best way forward is for banks to digitally transform to be able to compete in this fluid landscape.

In academic literature, digital transformation (DT) is being described as a "process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies' (Vial, 2019, p.121). In other words, digital transformation is not about digitization, but rather digitalization. Banks have already started using digital technologies to revise the value-creation pathways they have previously relied upon to maintain their competitiveness. To that end they will need to implement structural changes that will lead to positive impacts in the culture, leadership, and roles and skills in the firm. Following from the above, DT should not be seen as a single event in the trajectory of an organization, but a process where one may need to go through occasional iterations to realise sustainable results (Vial, 2019). FinTech can facilitate this digital transformation assisting banks in their main functions. For instance, in the provision of liquidity, not only can help banks to expand the range of their product and services stack, but also enhance the overall customer experience. It can also facilitate the maturity transformation by assisting in the accumulation of necessary funding resources in a more efficient manner, the reduction of compliance costs and the improvement in the precision of risk assessment (Starnes et al., 2017).

This need for digital transformation becomes even more pressing when considering the shifting competitive dynamics and non-bank entrants in the industry. There is no other space where this is more evident than payments. Technology firms like Google, Apple, Samsung, Amazon, Alibaba, known as BigTechs, and payment specialists such as Paypal, all have eagerly entered this space and launched solutions that sit across the entire value-chain of payments – from payment initiation to communication and processing (e.g., Apple Pay, AliPay, Facebook Messenger payments, Amazon Payments, etc.) (Shin, 2019).

Up to now, banks have managed to remain central as they control a big part of the infrastructure for the clearing and settlement of transactions which is seen as crucial to security. They are also innovating themselves and, in many countries, they have developed joint ventures to manage online payment solutions (e.g., Currence in the Netherlands) and offer mobile payment applications (e.g., Paym in the UK). However, the field of payments is not the only sub-sector that technology companies pose a threat to banks. For example, Amazon has been selling loans to the small businesses trading through their website for years, and in 2019 Apple launched a credit product through their credit card offering (Frost, Gambacorta, Huang, Shin, & Zbinden, 2019; Tanda & Schena, 2019). In both cases, tech giants have access to granular data (either trading records or payment data) to help them assess the credit worthiness of millions of customers, thus fulfilling the role of financial intermediaries in terms of reducing transaction costs and extracting rents from information asymmetries in the market.

The key advantage technology firms have over incumbent institutions in banking is that, through their online platforms and mobile application experiences, they are becoming the preferred customer interface and thus, in the long term, may comfortably incorporate many of the services banks (and FinTechs) are offering onto their platforms. This "envelopment" strategy (Eisenmann, Parker, & Van Alstyne, 2011) will reinforce their affinity with customers who may use them as an "one-stop-shop" to purchase various products and services from competing providers – a supermarket type model. If this works out, online platforms will gradually get access to a variety of customer data, and through aggregate record-keeping they will have a much superior view of customer behaviour giving them substantial advantages when it comes to offering personalized products. This kind of "superplatform" approach, however, is not new. In China, Tencent's messaging engine, WeChat, has been offering a variety of services early on in its development including social networking, music, web portals, e-commerce, mobile games, internet access, ride-hailing, and others. By incorporating B2C and C2C payments using QR codes and money-holding functions through its wallet, WeChat has been transformed into a gateway for mobile commerce and enhanced user retention (Tanda & Schena, 2019). Several additional financial services have gradually been added to its original messaging application, including crowdfunding, wealth management, and loan applications. With this approach WeChat has managed to "make money conversational" – a phenomenon, Brunton (2018) calls "chatification" of money – and build a fundamental infrastructure which can be used by external services as a channel of communication with their customers. While Facebook Messenger has adopted a similar setup incorporating P2P payments in their messaging services, they lack the richness of the ecosystem of additional services on top of their platform. Facebook's Libra initiative is for the most part an imitation vision of this ecosystem WeChat has been offering to the Chinese public for years – albeit with the wrapping of blockchain technology and a cryptocurrency at heart.

Another potential threat for banks comes from the emergence of challenger banks and neobanks. For instance, Aaron et al. (2017) highlights the possibility that the fierce competition from FinTech firms may lead to a reduction of bank deposits which in turn will severely impair their ability to provide liquidity. Buchak et al. (2018) indicate that at the end of 2017, approximately 33% of the mortgage loans in the US originated from FinTech firms. Although the terms, challenger banks and neobank are sometimes used interchangeably by authors, there is an important difference between these digital banks. A challenger bank leverages technology to simplify banking processes, has a presence both online and through a limited branch system, holds a banking license and offers cutting-edge, fully developed banking services. Therefore, it can potentially be the main competitor of an incumbent bank. Examples

include inter alia Monzo, Tandem, Starling in UK, N26 in Germany, and Revolut in EU. A neobank also leverages technology to provide current and savings accounts, payments services and credit products, however it has no physical presence through branches, does not hold a banking license. Thus, they depend on a partner bank to offer more traditional banking services.[8] In a sense, the neobank is only the service intermediary that delivers the products, receives fees from clients and pays fees to the traditional bank.

Learning from such business models and as a response to the offence from high-tech companies, incumbent banks can take advantage of their central position in the financial system and try to build similar platforms offering a variety of services from third-party providers. As it stands, banks maintain several attributes that give them an edge over both technology giants and FinTechs. First, their large customer base and access to credit history data allows them to make better assessments regarding customers' financial needs and inherent risk (Navaretti et al., 2018). While large e-commerce providers, like Amazon, and social media firms, such as Facebook, have tremendous access to behavioural data, either through purchasing patterns or user-generated content, they are missing a piece of the puzzle: credit history data. This is a significant shortcoming in the context of making lending decisions. While legislations like PSD2 in the EU or Open Banking in the UK will make it easier for non-banks to access such data through connecting to banks systems (subject to customers' permission) it remains to be seen whether big tech firms will move to acquire the necessary license to allow this. Loosing this advantage and giving up customer data could be a major blow for banks which have complained to regulators for the information asymmetries open banking rules can bring.

Nevertheless, there is one more strategic advantage that banks currently enjoy. They are trusted with customers' identification and reference data (e.g., customer IDs, proof of address, etc.) and so will safeguard customers' identity when they transact online. To capitalize on the above they will demand to build further on their existing infrastructure and take advantage of new authentication protocols and communication standards to interface with external marketplaces or platforms. Birch (2014) in his book "Identity is the new money" discusses how the convergence of identity and money has accelerated with the extensive influence of social media and mobile phones leading us to rethink identity in the digital age. To that end, managing people's privacy and confirm their identity online will be a vital benefit. This will give choice to consumers when they want to share some of their credentials but remain anonymous to certain providers or networks.

Whether "identity is the new money" or "trust is the new currency", banks will need to intensify their efforts to compete in this fast-changing global economy and redefine their role in the future financial services industry. The rate at which banks will adopt new technologies depends on the speed that their customers and competition will accept these technologies (Camera, Casari, & Bortolotti, 2016). This depends as well on the characteristics of the customers those banks attract. For example, it has been documented that FinTech companies target millennials because of their high degree of technological sophistication and their mistrust in the traditional banking sector (Vives, 2017). The success of the banks will largely depend on all the factors we discussed above and will also explore in the next section by looking at the future characteristics of banks. By and large, digital transformation initiatives will better prepare incumbent banks to address competition and evolve by exploring new business models and digital strategies.

4. The future of banks and opportunities for development

Over the years, banking institutions have been a textbook example of slow transformation and "resistance to change", managing to maintain their core function as information brokers and intermediaries. While this ratifies their pivotal and indispensable role in modern capitalist societies it is also, to a large extent, due to strict regulation grounded in constructs of the past industrial economies and the lessons-learned from several financial crises over the past century. The dawn of the 4th industrial revolution and emergence of data-oriented digital technologies is deemed to change that. It is expected that transformation in the sector will accelerate as technology will affect business models of organizations dramatically, reinforced by shifting customer preferences, unstable global relations, and even revised regulatory interventions.

Visualizing the future in such liquid and critical times is not easy, but there is no harm to try and think about plausible scenarios. Such exercise can help guard against fragility and develop foresight capabilities to deal with forthcoming challenges. Below is an attempt to bring together all factors, including the status quo of banking, and project these to the near future keeping in mind the strong gravitational pull of "path dependence" – i.e., the irreversible influences of previous generation structures (Liebowitz & Margolis, 1995) – that characterizes extant organizations and technological infrastructures. President of the Institute for the Future, Roy Amara, famously coined that "we tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run." It is debatable whether the 10 next years in banking can be considered as "long-term", but in any case, one needs to go about with caution when making claims for the future.

4.1. *New business models[9] for digital ecosystems*

Based on the discussion above the nature of banking as well as the institutions that operate within this context – the banks – is on a route to change considerably. The most important element in this transformation is that, for banks to remain competitive, they need to address competition from many different stakeholders that were not part of their traditional competition thus far. Both, FinTechs and new digital banks but also entrants from the high-tech industry (producing software or hardware), as well as players from the telecommunications, retail, and other sectors are gradually moving to claim parts of the markets in different segments of the financial services architecture (Dapp, Slomka, & Hoffmann, 2014). It will be hard for banks to remain competitive in this market, but there are reasons to believe that experimenting with new business models such as platform-based business models can prove to be beneficial. The changing regulation in different parts of the world, such as new rules around open banking, are reinforcing the possibility of banking becoming platforms. We expect this to be the norm in a decade from now as many economies are transitioning to this framework.

A platform business model dictates that an organization becomes an intermediary or a network that matches providers of products and services with people who demand similar requirements. While this is already at the heart of what banks do (i.e., matching people who demand capital with people who can supply it through their deposits), digital technologies such as open APIs create many more possibilities to "broker" entire services and products from external providers. Banks have shown signs of collaboration with FinTechs, especially after PSD2 in the EU demanded banks to systematically share customer account data and allow initiation of payments. Creating such "FinTech ecosystems", banks will potentially play the role of the platform provider servicing core functionalities such as customers identity, accounts provision, payments processing and others, while ensuring that there is "order" to the buying and selling of products on their platform. For example, they can provide immense value to customers by ensuring the quality and seamless integration of the FinTechs that use their platform, making recommendations, and offering services that they could not themselves offer (Zachariadis, Ozcan, & Dinckol, 2018).

[8] https://fintechmagazine.com/banking/difference-between-neobank-and-challenger-bank

[9] Roengpitya, Tarashev, Tsatsaronis, and Villegas (2017) provides an excellent analysis on the current business models of banks

However, open banking goes well beyond the strict boundaries of finance and "FinTegration". As API types and standards grow, financial institutions will be able to interface with organizations, applications and platforms outside banking and provide new possibilities to sell their, and their partners, services by taking advantage of access to novel data (Zachariadis & Ozcan, 2017). For example, one can think of a situation where a customer uses her banking credentials and authentication mechanism to log-in to her Amazon account (or another e-commerce platform), choose the product of choice, and by allowing access to her trading data online as well as her credit history, get instant approval for a loan which will pay for the goods automatically. Several similar examples can be constructed for commercial clients in the business banking arena (e.g. integrations with accounting software and suppliers). This will allow for the ubiquity of banking services entering other industries, crossing boundaries and "banking everywhere and anytime" (King, 2018). In his original blogpost analysis of the Facebook Platform launched in 2007, Netscape cofounder Marc Andreessen, identified that a platform is "a system that can be reprogrammed and therefore customized by outside developers – users – and in that way, adapted to countless needs and niches that the platform's original developers could not have possibly contemplated, much less had time to accommodate.[10]" This definition of a platform demonstrates nicely the limitless possibilities that integration of banking services through APIs could provide. The bank of the future will want to allow substantial access to outside developers so that it gives them inspiration to innovate in ways they couldn't possibly contemplate.

Extant literature discusses extensively the economics of platforms and identifies ways in which banks will need to strategize to encourage the creation of ecosystems and open innovation in their midst (Zachariadis et al., 2018; Zachariadis & Ozcan, 2017). Observations suggest that leading banks in the near future will be more open, realise and treat current competition as their "customers", and cultivate network externalities on their platform to encourage competition between their partners and accelerate growth. To realise many of the above opportunities, banks will have to invest and transform substantially during the coming decade to provide a seamless platform experience not just for their consumers, but also their suppliers who will be a new set of business for them. This means that they will also need to systematize the onboarding experience for third-party providers with a similar process as that of their retail customers. Such interventions will set them to a digital path characterised by increased modularity (compared to integrated or pipeline, "older" architectures), which will provide the building blocks for additional functionalities to flourish.

4.2. Mastering the data economy

The profit centres of a business model as previously described will change as banks move from brokering money to brokering services or access to services. We have already explained how information is central to the "nature of the bank" – in both cases, data will play a substantial role. So far, banks have been effective in analysing credit history data to assess fiscal risks. In the same fashion, they will master new types of data sources that will allow them to unlock new business. In this context, analytical technologies will help them bring results forward as they will be able to predict sooner and better the needs of their customers (Navaretti et al., 2018). It is unclear how far the banks will go within the next decade using artificial intelligence to automate customer journeys utilizing autonomous engines. At this stage banks are still coming to grips with the use of big data and predictive analytics to unlock their data assets. They have been described as "rich in data, poor in insight" due to data silos and lack of coordination between their business functions to aggregate information. How many times have you received a call or a letter from your bank asking you if you're interested in getting a new credit card or a loan when you are already over-credited with your cards and already bought a loan?

The journey of digital transformation that many banks are currently undergoing will equip them to face their legacy challenges (both around technology and organizational structures) and take advantage of arising opportunities in the data economy. Properly employing data can add immense and often unforeseen benefits to various functions and tasks across the business: from fraud, anti-money laundering, and cybersecurity to achieving operational efficiencies, effective marketing, and selling personalized services (Liberti & Petersen, 2019; Puri & Rocholl, 2008). It almost goes without saying that banking institutions will will not follow through with the above changes will struggle to maintain their profitability as customer mobility between competitors is expected to rise due to lowering switching costs facilitated by data sharing frameworks. Success in the coming decade depends on how well banks will transform and take advantage of digitalization to create new value, cultivate ecosystems, and leverage unique data resources to grow across and beyond industry boundaries – after all "data is the new oil", a phased coined by Clive Humby in 2006.

4.3. Agility and digital ambidexterity

It is well documented in the academic literature that digital technologies can assist organizations to quickly adapt to changes in their environment (Fitzgerald, 2016; Kohli & Johnson, 2011). Being able to adapt and be agile is a key principle for competitive organizations especially in times where a market is going through significant transformation. Sambamurthy et al. (2003, p. 245) describe organizational agility as the aptitude to "detect opportunities for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise". As the competitive environment in banking is shifting drastically with increased frequency, successful banks will be the ones who learn how to adapt quickly and with easiness. However, quick responses to the changing rules that govern the banking landscape are not only based on technological capabilities and flexible organizational structures, but also on leadership and strategic decisiveness. There will be times that banks will need to gradually sacrifice established revenue lines to reshape their business model and seek new opportunities with more potential in the future. To use the words of the famous Austrian economist Joseph Schumpeter, this process of "creative destruction" fits well with the innovation paradigm of our time, where commercial growth largely depends on a firm's ability to revolutionize economic structures and create new opportunities by destroying the old. In the context of competition, Steve Jobs in 2013 summarised the above by pointing forward that "if you don't cannibalize yourself, someone else will".

To satisfy the above conditions, banks of the future will need to be "digitally ambidextrous" – a concept that is used to show how an organization needs to be at the intersection between innovation and change (Gupta, Mejia, Gianchandani, & Kajikawa, 2021). This is an important framework of action to consider when incumbent banks are trying to digitally transform during times of disruption as they have a clear disadvantage against smaller and more agile or "lean" FinTech startups and seasoned high-tech firms. In response they will need to sustain a successful balance between maintaining their core capabilities or offerings (i.e., exploit existing resources), and exploring future opportunities (i.e., leveraging digital innovation and new business models). It is the tension of doing these two tasks together and being "consistently inconsistent" that poses a challenge to many incumbent banks. It is expected that future banks will be more comfortable in developing ambidextrous capabilities such as ambition, discovery, experimentation, scaling and learning with data. This will equip them to respond to the emerging competition in the industry.

[10] Andreessen's original blogpost can be found here: http://web.archive.org/web/20080229163206/http://blog.pmarca.com/2007/06/analyzing_the_f.html

4.4. Sell experiences not products

It has already been discussed how the increased digitalization in financial services and the emergence of mobile devices and the app economy have transformed the way people interact with money and their banks. Digital transformation agendas already set by many banks have in their plans to develop further their mobile and digital communication channels and find new ways to engage consumers through personalized nudges and notifications based on dynamic data sources. These are usually combined with human support for complex interactions, to enhance problem solving and increase empathy. While these steps are signs of progress many banks are still hostages of their product-oriented culture and organizational structure which were inherited from previous generations. However, future banks will not be bound to specific customer propositions such as mortgages and loans. Services will be more tailored for customers on an ad hoc basis depending on their dynamic needs and on the right time. Data will be central to this endeavor as will the analytical technologies that will identify such opportunities. A quick example, albeit a simple one, could be around the use of different accounts – e.g., current, savings, ISA, and so forth. These distinctions could become obsolete if there is a smart way to manage finances in a more aggregate way, but still manage to allocate interest depending on the deposits or investments. Commoditized products may still be around but can be used to categorize customers based on subscription models and premium access to offerings.

The above model implies that banks will be more geared to investing in experiences and not products. Indeed, the emergence of the app economy and the aggregation of services and financial (and other) data requires a fundamental rethink of the way money and information is being communicated and "experienced" by consumers. As the entire spectrum of monetary situations is becoming "appified" through "in-app-infrastructures" or "platforms" and, in-turn, those are becoming the default access point and interface for all things, one can begin to change their experience and use (Brunton, 2019). The design element then moves from the physical instantiations of money to the digital layer of mediation that is the app.

While the role of experience as an important part of the mediation in selling goods and services is not new, it was revived through firms such as Apple which paid particular attention to the emotional components and events packed into their services and products (Gallo, 2012). Apple used this approach to design Apple Pay that was launch in 2014 to replace the "outdated and vulnerable" bank card (Tkacz & Velasco, 2018). During the launch of the product, Apple's CEO Tim Cook made an explicit reference around how many have tried to build digital wallets and failed before as they focused more on their self-interest rather than the user experience (UX). By winning the "experience" game it may be the decisive factor on who will "collect, fence, own, leverage the commons of transactional data" and "bring purchase histories together with payment information together with locational, credit, social network, or other histories" (Maurer & Swartz, 2015, p.226). As it can be understood, designing user experiences for future banking services may also mean a complete overhaul of existing channels. For example, having the customer in mind, banking may largely happen in the background automatically – "invisible banking" – without much human engagement. Longstanding methods of customer interaction, such as branches, will receive a complete redesign to complement digital experiences (i.e., become "phygital" stations),[11] and digital interfaces like chatbots (e.g., conversational AI via audio or text), visual holograms, virtual and augmented reality, will appear more frequently in "places of interest" where customers can be served with easiness.

4.5. Personalization

Ten years forward, AI applications will be implemented (one way or another) in most parts of banking creating significant benefits for customers and organizations. Many AI technologies and applications will be commoditized by then and cheaper to purchase and implement (some of them as a service), so, banks with the best access to aggregate, clearly labelled, and relevant data will have an advantage in creating intelligent services according to their customers' needs. In the age of "smart", banking services may be trigger based on dynamic data that are being collected continuously from customers or businesses. Easy-to-think examples are smart payments or transactions that will charge customers based on their usage of services they purchase taking into account discounts and other offers (streamed through APIs from retailers) that would otherwise be impossible for the consumers to follow up and apply. A smart wallet or bank account of some sort. Such applications are easier to imagine in the case of "super-app" interfaces or dashboards through which you and I will be able to order food, book doctor's appointments, concert tickets, and reserve a cab. Integrating a layer of money interactions that interfaces directly with your bank would mean a seamless and smarter experience. Following regulations such as GDPR and PSD2, it is anticipated that consumers will have better control and ownership of their data choosing who to share it with and for how long. The matter of trust in this context is crucial. This is a space banks will really need to champion and help set the agenda, especially considering incidents such as the Cambridge Analytica scandal that put Facebook on the spot regarding customers privacy and the use of their personal data, thus significantly damaging their data security reputation.[12] Will banks be the unlikely heroes for the people and become their trustworthy allies in the race for data privacy and trust?

Access to data and the implementation of smart money software do not only help track and deliver on user behaviour but, occasionally, can also nudge users to make better decisions and enjoy superior outcomes. Nudge theory is a concept that is originally based on the general approach of "soft paternalism" first proposed by Sunstein and Thaler (2003). The theory, which is boroughs from the fields of behavioural economics and psychology, starts from the premise that "individuals make pretty bad decisions – decisions they would not have made if they had paid full attention and possessed complete information, unlimited cognitive abilities, and complete self-control". In that context, one could offer some positive reinforcement through technology to improve behaviour. In finance, there can be many such applications varying from savings, investments, and insurance. FinTech startups and technology providers such as Pariti and Personetics offer solutions that engage consumers in pursuing their financial objectives and help them save more. Banks can use nudge technologies to present personalized real-time insights embedded in the bank's digital experience to help customer address better their financial affairs. To that end, AI can allow for notifications or 'nudges' that are tailored to each person and delivered at the right time and place (e.g., interface or application). Designing a systematic framework for (hyper-)personalization would also require considering customers' aspirations and have provision for co-creation of products (i.e., user-driven innovation) (Jain, Paul, & Shrivastava, 2021). Younger digital banks such as Fidor Bank have managed this through active online communities that give a voice to the customers on how the bank is run as well as key decisions about products. Ultimately, understanding customer behaviour and offering personalized and simpler products and responsive services, provides the cornerstone for a more trusted and relevant relationship with consumers. Confidence in the services that people are consuming will fuel trust and create loyalty.

[11] https://www.weforum.org/agenda/2020/06/phygital-strategy-isolation-economy/

[12] See article "Facebook's Slipping User Retention" accessed here:https://www.pymnts.com/facebook/2019/facebooks-slipping-user-retention/?utm_source=Push+notifications&utm_medium=Push+notifications&utm_campaign=Push+notifications

It's a challenging task to envision how technology will shape banking the next few years. Progress largely depends on multiple factors many of which we discussed above. Also, big part of the puzzle lies on the speed to adoption and development of upcoming technologies that currently have no application in finance yet. Technologies such as quantum computing and 5G will increase the volume and speed of data crunching and accelerate further the creation of data-driven models in banking. The predictive nature of knowing where people or businesses are in their lives will allow banks in the future to do multiple times what they can do today and create several opportunities to provide value. The interaction between the customers and automated services (e.g., chatbots, voice-commerce, etc.) will eventually become dramatically improved and much more instantaneous. Autonomous machines running "errands" on behalf of people will eventually need to possess their own payment "license" giving rise to machine-to-machine financial interactions (e.g., PayPlate car-to-car payment engine that won first place at the Open Bank Project[13] hackathon in London in 2016).

4.6. Social responsibility and financial inclusion

A positive characteristic of the current FinTech revolution is the attention entrepreneurs and investors have given to positive change for society and particularly underprivileged groups of people. To this end, technology can really help tackle issues around financial inclusion and provide equality of opportunities to access financial services (Demir, Pesqué-Cela, Altunbas, & Murinde, 2020). Currently, incumbent financial institutions have given little attention to this matter mainly due to unsustainable business models and low business incentives. This is one of the reasons why in certain developing countries FinTech firms and telcos have entered the payment and lending space attempting to bridge the existing gap in the provision of basic banking services. For example, several papers showcase the positive impact of mobile money on financial inclusion (see for example Jack and Suri (2014), Suri and Jack (2016), Sy, Maino, Massara, Saiz, and Sharma (2019), Suri (2021)).

As technologies help to reduce costs in customer acquisition and servicing, banks will be in a much better position to provide easy access to all demographics and create products for disadvantaged populations such as homeless people, immigrants, and other sensitive groups. It is expected that banks will also be more socially responsible when it comes to issues around climate change, diversity, health and work-life balance, and others. For example, they can increasingly support environmental issues such as recycling and waste management and encourage sustainable behaviour by customers. This can be done via their digital channels of communication with the customers and even embed some practices in their products – for example, they can incorporate recommendations for green investing and rank opportunities based on carbon emissions data.

5. Conclusion

We have undertaken an overview of recent research on the FinTech revolution and related opportunities and risks for banks. In addition to the insights from the existing literature, we have generated additional interesting conclusions from statistical analysis of high-quality bank level data from 115 countries over the period of 16 years. Below, we base on this body of knowledge to offer some promising research ideas as well as some key implications for policy makers and practitioners.

5.1. Promising research ideas

The speed at which technological developments emerge, the proliferation of FinTech firms, their entrance in new spaces and the provision of novel financial products and services, and the increased impact of BigTech companies in the financial system, altogether bring FinTech to the centre of discussion among practitioners, policy makers and regulators, and researchers. Given the status quo of the global financial system following the outbreak of the Covid-19 pandemic, a promising research idea is investigating the extent to which FinTech firms can work with traditional financial institutions to generate innovative financial products and solutions for firms and households in order to expedite the economic recovery process. Companies that have leveraged FinTech innovations such as Amazon and Tescent have exhibited not only considerable resilience during the Covid-19 global pandemic but have also increased significantly their revenues. At the same time, FinTech applications have helped some governments deliver support to households and firms, without requiring them to visit a bank branch or a government agency. Hence, there is urgent need for empirical research to generate evidence on the relationship between banks and FinTech start-ups since the outbreak of the Covid-19 pandemic to the present.

Another interesting research idea is to explore whether FinTech has indeed the potential to change behaviour, perhaps in a theory of change whereby FinTech moderates company financing behaviour and ultimately affects inclusive growth outcomes, and whether the behavioural change differs across developed and developing countries. Also, FinTech may offer new perspectives in other aspects of the theory of corporate finance, including the cost of capital and dividend policy by considering transactions through the FinTech space. New research should also aim at developing new methodologies, invoking big data, artificial intelligence and machine-learning techniques, that could provide an angle on how to understand the impact of FinTech in producing positive changes in economic and financial transactions, as well as other financial spaces. The generation of big data provides opportunities for innovations in econometric techniques. The research can provide valuable information not only for practitioners but also for regulators and supervisors. Moreover, investigating whether FinTech solutions can increase the profitability and performance of a company in a certain industry, improve price discovery and increase the speed of settlements in trading, and mitigate information asymmetries are also topics that future research should focus on.

Experimental research methods would shed light on the new competition between traditional banks and the FinTech start-ups, BigTech and neobanks or challenger banks that have entered the financial services sector as new competitors. Special attention should be paid to the FinTech start-ups which are active in the key segments of financial services such as payments and remittances, lending, enterprise financial management, crowdfunding, enterprise technologies for financial institutions, trading and capital markets, insurance, personal financial management, wealth management and digital banking. Finally, an important area that requires further investigation is whether the technological developments are those that drive the emergence of FinTech in financial sector in the same way as in other industries, or it is the existing unsolved issues in financial sector that have necessitate the development of more efficient solutions based on technology.

5.2. Key implications for policymakers

An important consideration for policymakers is related to the banking sector and the potential disruption of FinTech revolution, especially in the provision of liquidity. The earlier discussion in the paper suggests that the strict banking regulations and the emergence of FinTech companies in the financial services industry have contributed to the disruption. Certain FinTech solutions have led to disintermediation mainly in payments and credit space, partly benefiting from the current lenient regulation globally. We noted earlier that FinTech firms cannot replace banks but rather coexist with them, cooperate, or potentially become like banks. This argument is reinforced by the fact that any technological advantage is not sustainable in the long run because the adoption of technology, same or better, by new or current competitors is

[13] See here for more information: https://www.openbankproject.com/hackathon/

fast, and ceteris paribus the technological convergence may be imminent. Nevertheless, policymakers should ensure a level playing field for all participants in the banking sector, by introducing policies that promote the cooperation or fair competition between banks and FinTech firms.

Another important issue for policymakers is that multidisciplinary dialogue and global collaboration on a basic regulatory framework and a set of policies regarding FinTech is required. A common array of certain regulations is necessary to, inter alia, safeguard the stability of financial system, ensure smooth operation of financial markets, protect consumers, and improve the social and economic welfare. However, this has yet to happen because of differences in approaches and interests among governments regarding FinTech, as well as the diversity of the global government agencies that have a stake in the industry. FinTech is gaining pace globally and has contributed to the improvement of financial inclusion. However, the level of diffusion (overall and regarding specific applications) differs across regions and jurisdictions, depending principally on consumer needs, financial and technological infrastructure, level of development, regulatory framework, and available capital for the required investment. There is urgent need for discussion among policymakers for a global regulatory framework and response to FinTech. Although a generic regulatory framework may be possible, regulatory approaches tailored to the distinct FinTech characteristics, use and potential in each jurisdiction may be required. The use of RegTech and SupTech may facilitate the efficient and speedy implementation of such approaches.

Privacy and consumer protection are also issues in the FinTech era that policymakers should focus more on. The concerns about privacy are not new, but the increased digitization and interconnectivity that is driven by FinTech creates more access points and favorable circumstances for criminals to exploit personal data and engage in illegal activities. The consequent intermediation in some FinTech applications and the complexity of some FinTech products may also foster fraudulent activities, predatory practices, price manipulation and asymmetric information if there is not any strict regulation in place. Moreover, "cherry picking" practices may lead to financial exclusion and price discrimination when collected data is not used in an appropriate way by the underlying algorithms. For these reasons, policymakers should proactively seek to understand and acquire extant knowledge about FinTech applications and their underlying mechanisms. Implementing appropriate regulatory strategies and providing an environment of mutual knowledge exchange and constructive communication between regulators and FinTech firms is key. This will eventually lead to an increase in the capacity of informed regulators who can introduce efficient and appropriate legislation that will aim at creating a beneficial FinTech ecosystem for everyone. Also, this will help FinTech firms to understand clearly the current and future policies and ensure that all their processes can comply.

Some of the existing challenges have become more significant because of the entry of BigTech companies in the financial services sector, given their market power, customer reach and technological advantage. The size of the market, the large number of market participants, the disruptive and "winner-take-all" character contribute further to existing difficulties for regulators. Regulation for the future financial system will need to tackle such questions and challenges, and where possible use technology not only to safeguard consumers and ensure market stability, but also for the positive potential of the global economy.

5.3. Key implications for practitioners

A key aspect for practitioners in relation to FinTech is the increase in financing opportunities, in addition to financial services by banks. FinTech lending can help start-ups and MSMEs by reducing credit and systematic risk, creating efficiencies, and reducing costs by offering a wide variety of credit solutions. It can facilitate the diffusion of information so that any information asymmetry and adverse section problems are minimized. In addition, FinTech credit solutions mitigate gender discrimination in financial access, promote equality and social cohesion and eliminate geographical barriers. Especially crowdfunding offers the opportunity to bridge the gap between supply and demand for entrepreneurial finance and it can be a crucial advertiser for the attraction of larger funds. More importantly, different types of crowdfunding (reward-based, donation-based, and equity-based) can offer additional benefits for start-ups and MSMEs. Also, FinTech can potentially assist larger firms in their financing either offering credit solutions or the option of Initial Coin Offering (ICO) which is based on blockchain technology and offers more security, liquidity, and transparency than other financing options.

Another key conclusion for practitioners is the potential of a FinTech ecosystem where banks, FinTech firms and neobanks co-exist can promote the development of new banking products and services and the improvement of existing ones, while it can boost the efficiency and speed, in the provision of financial services by traditional financial institutions, as well as reduce the cost of intermediation. Fintech can also assist banks in gathering the necessary funding resources, opening and managing more savings and current accounts, gaining access to emerging markets, where financial infrastructure is scarce, reducing the compliance costs and improving the precision of risk assessment in areas of enhanced identity verification, investment profile and consumer behaviour. Moreover, Fintech solutions can potentially create opportunities for the banking sector in the provision of liquidity and the improvement of the information collection and management. The logical route for the banks is to seek cooperation with FinTech firms and neobanks, as well as adopt FinTech solutions, but there are several underlying challenges that can make this hard to materialize including the strict regulation for banks and the regulatory arbitrage by certain FinTech firms, the inflexibility of the current regulation, the higher legacy costs of banks to implement new technologies, the conflicting incentives in the collection and processing of information, and the potential loss of the personalized relationship of the bank with customers. However, the Covid-19 pandemic has eliminated the barriers to digital transformation in the financial sector, obligating many traditional firms to spend overwhelming resources for infrastructure.

The entrance of fintech start-ups in the financial services industry has led to a shift towards a more customer-centric approach to financial services. Consequently, there has been increasing demand by traditional financial institutions for applications that can provide high-quality customer experience. FinTech allows for increased integration with consolidated digital solutions that can satisfy various needs, while reducing frictions, such as transaction fees, endless paperwork, external software dependencies and manual processes. Digital banking can be considered one manifestation of this trend, with digital-only banks becoming more and more popular. The Covid-19 pandemic has accelerated the adoption of digital banking solutions by incumbents as the demand for online services has increased considerably. As more people get comfortable with communicating via mobile applications and the internet with their banks, digital banking is expected to continue growing in the years to come. Also, open banking is another manifestation of the second trend that promotes data networking and secure sharing of information, through a unified management of accounts. The use of blockchain technology, AI and ML, robotic process automation (RPA) and biometric security systems, digital currencies and IoT contactless payments are trends expected to promote further the customer-centric approach to financial services.

Furthermore, the management of Big Data will also be a crucial aspect of the financial services industry. The collection of data is an important element of the daily operations in every financial institution. Hence, there is a continuous need by the industry for powerful tools for the processing of unstructured and structure data. The efficient management of this data is crucial for market players to recognize trends and opportunities, improve products and services, standardize processes,

and offer better customer experience. With the anticipated digitalization and the consequent increase in the amount of information gathered in the coming years, FinTech applications can assist further in the management of data, from processing to storage. Consequently, there exists a need for more investment by the firms in cybersecurity infrastructure to eliminate potential risks such as corporate data breaches, ransomware, phishing, data leakage, hacking, insider threat, money theft and many others.

Overall, researchers, policy makers, practitioners and civil society agents who are watching developments in the FinTech space continue to generate new issues and research questions. For example, there are important aspirations by the global community, arising from the UN 2030 Agenda for Sustainable Development (UN-2030-ASD) and the G20 High-Level Principles for Digital Financial Inclusion(G20-HLP-DFI) which highlight the urgency of harnessing the potential of FinTech to reduce financial exclusion and the long-standing problem of inequality in health and education, now exacerbated by the COVID-19 global pandemic. The search for breakthroughs, in research and policy, is on.

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CRediT authorship contribution statement

Victor Murinde: Conceptualization, Validation, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Efthymios Rizopoulos:** Conceptualization, Investigation, Formal analysis, Resources, Writing – original draft, Writing – review & editing, Visualization. **Markos Zachariadis:** Conceptualization, Validation, Resources, Writing – original draft, Writing – review & editing, Project administration, Supervision.

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Appendix

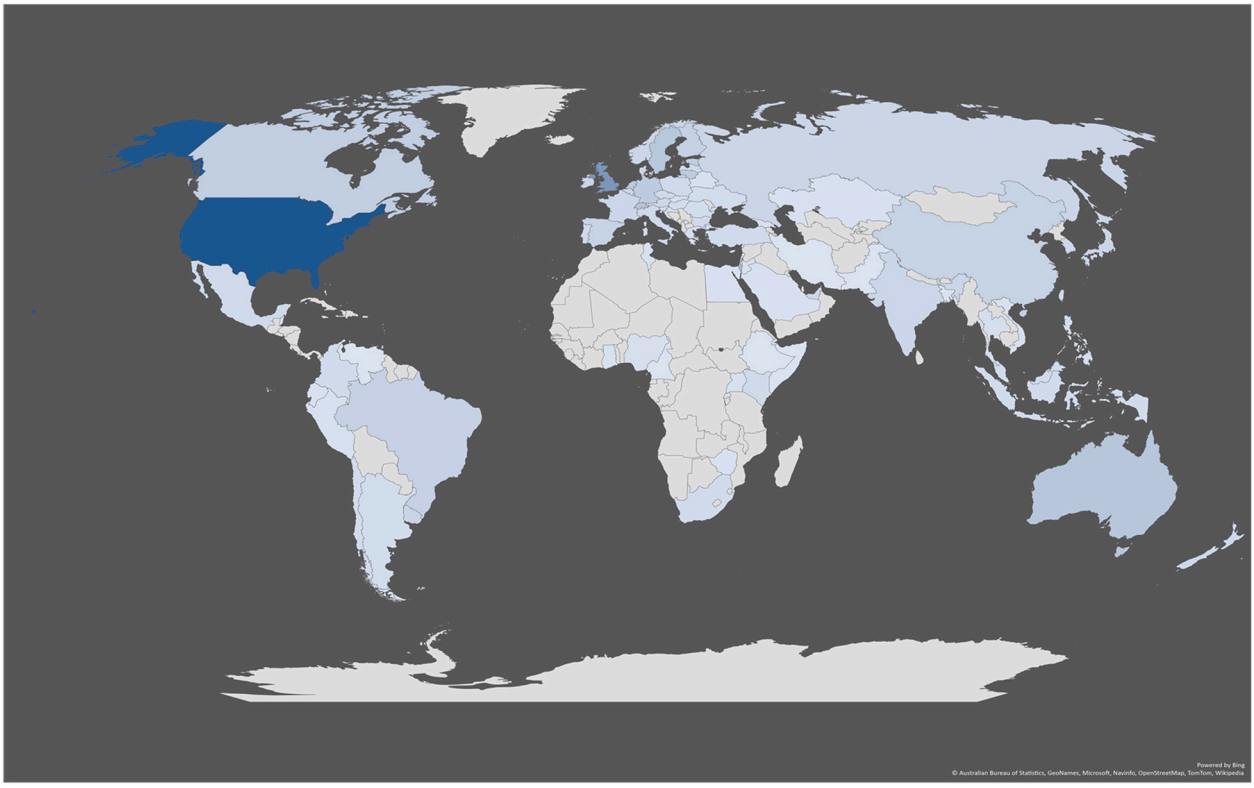

Fig. A1. Fintech start-up ecosystem strength (Global Fintech Index). Source: https://gfi.findexable.com/fintechs, Authors' Estimation

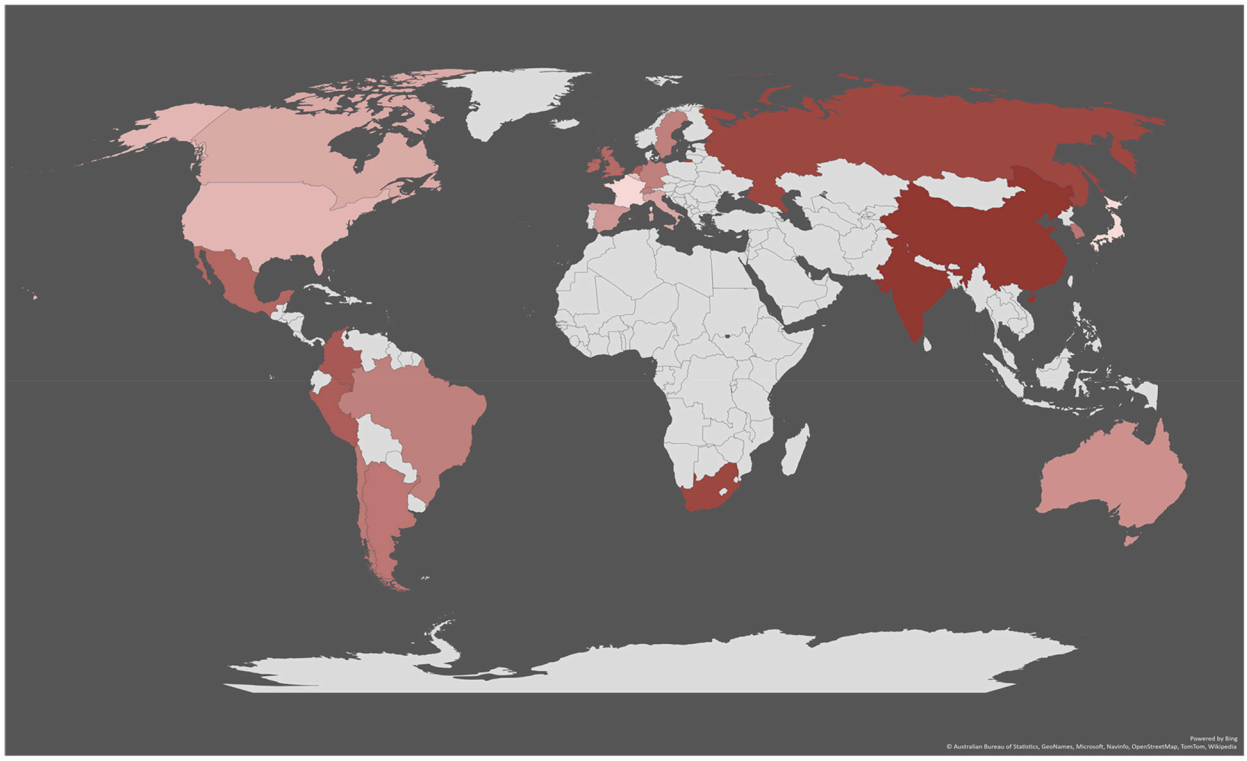

Fig. A2. Global FinTech Adoption Index. Source: EY (2019), Authors' Estimation

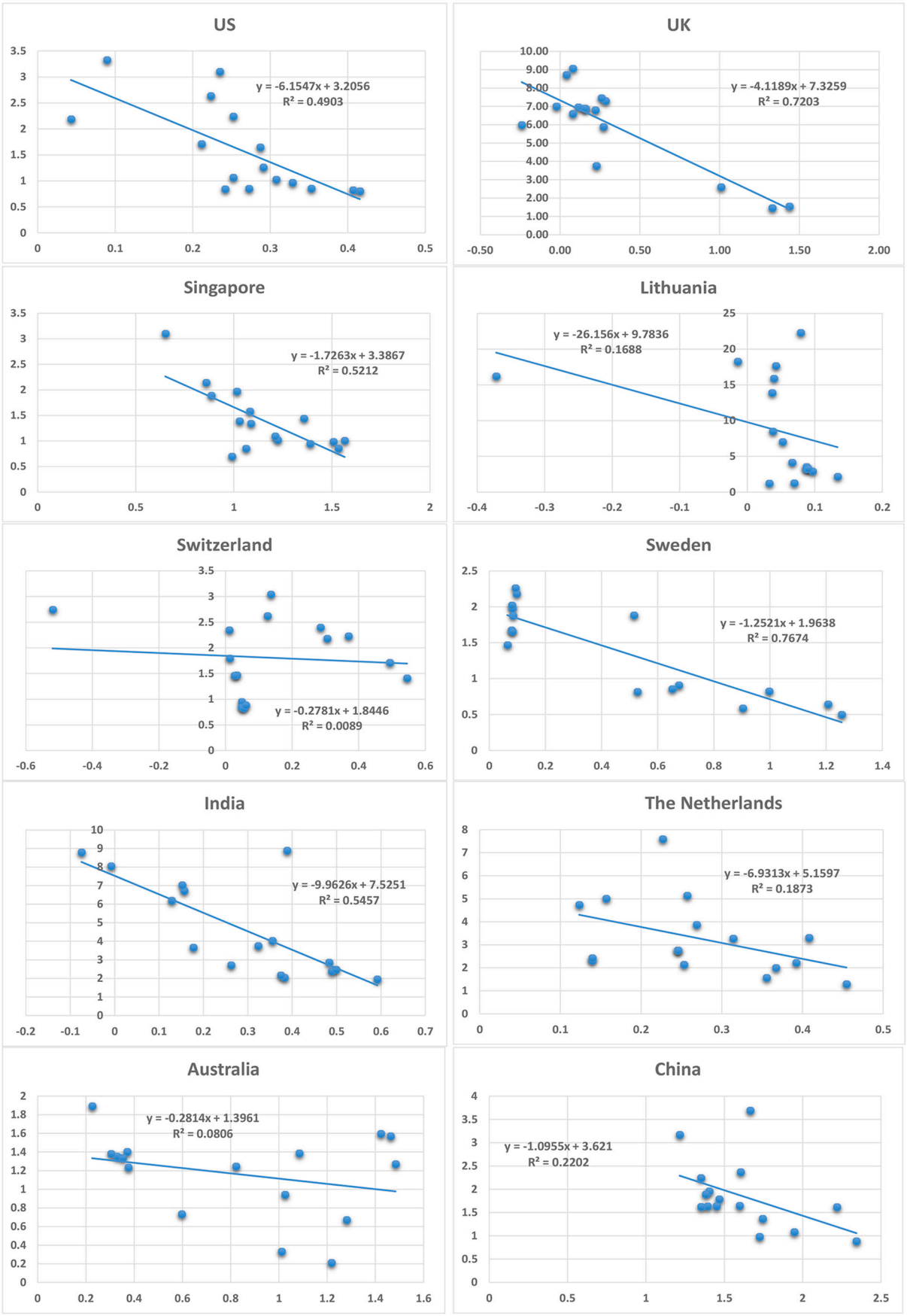

Fig. A3. Scatterplots of profit/loss before tax (y-axis) vs non-performing loans/gross loans (x-axis). (Source: Authors' calculations using data from BankFocus, ECB, and FDIC)

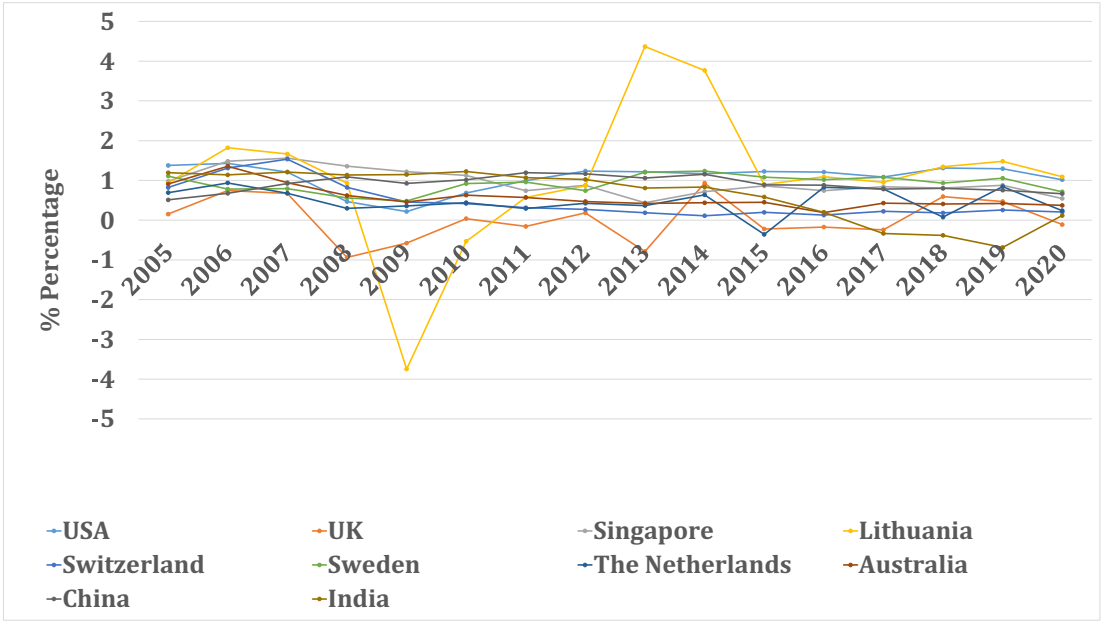

Fig. A4. Averages of ROAA for banks in countries with strong FinTech ecosystems. (Source: BankFocus, ECB, FDIC, Authors' Estimation)

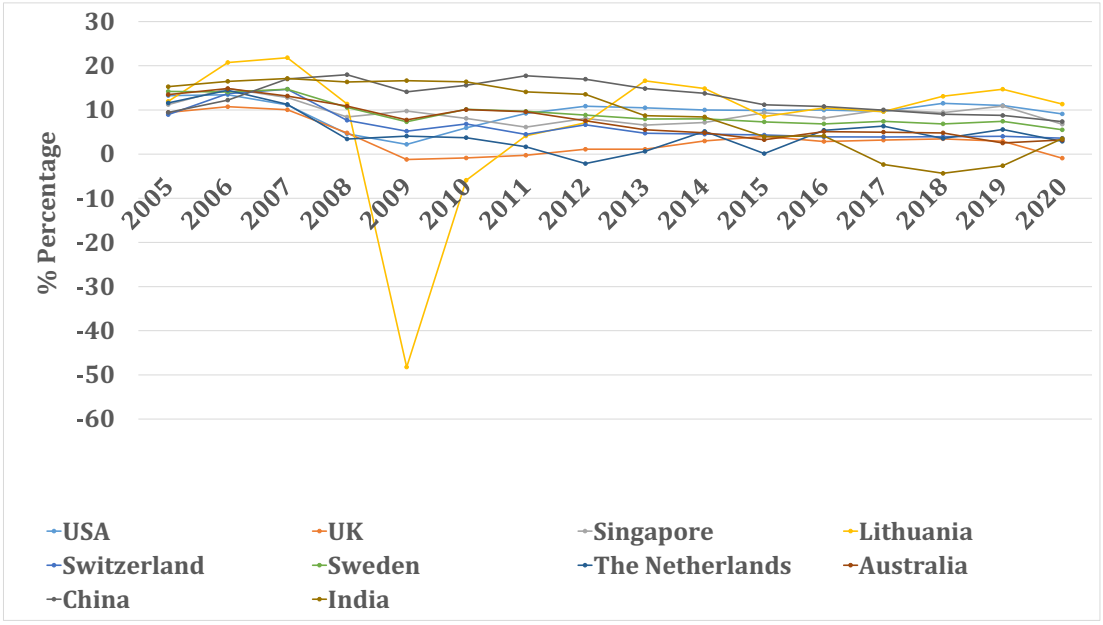

Fig. A5. Averages of ROAE for banks in countries with strong FinTech ecosystems. (Source: Authors' calculations using data from BankFocus, ECB, and FDIC)

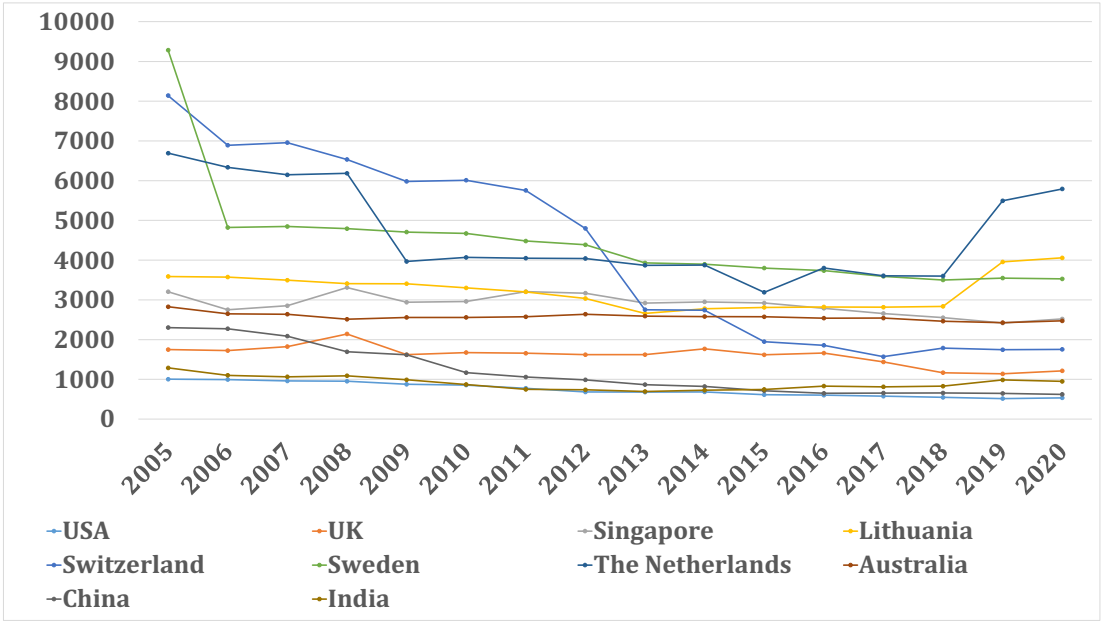

Fig. A6. Averages of HHI of banking sector in countries with strong FinTech ecosystems. (Source: Authors' calculations using data from BankFocus, ECB, and FDIC)

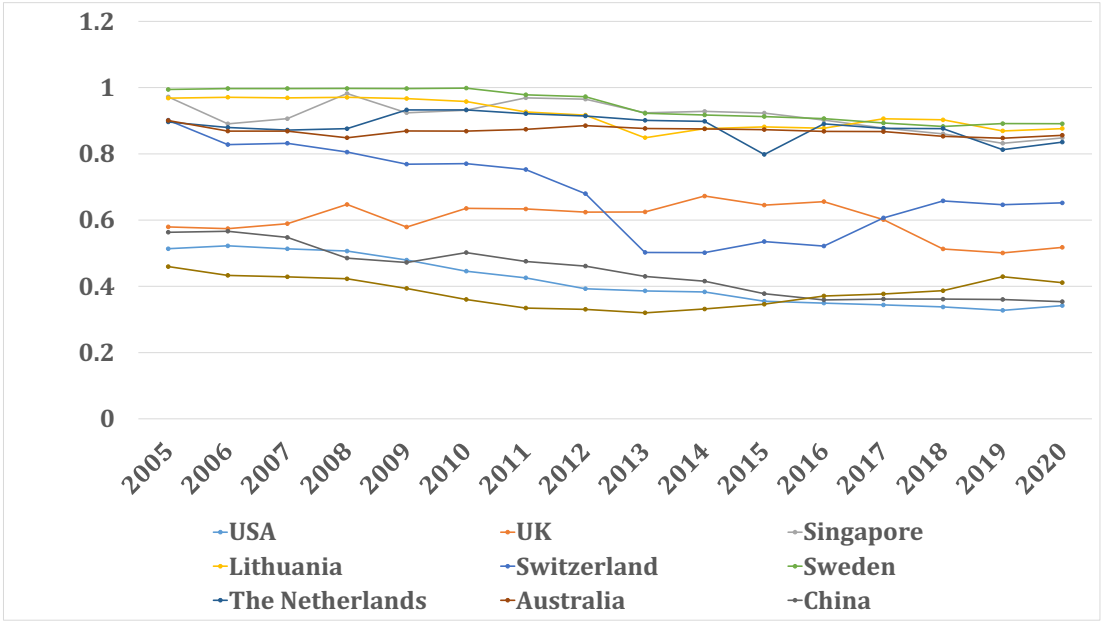

Fig. A7. Market share of the 3 largest banks in countries with strong FinTech ecosystems. (Source: Authors' calculations using data from BankFocus, ECB, and FDIC)

Table A1
FinTech Start-ups & Scaleups in which major UK banks have invested.

	Company	Launch Year	Valuation	Funding	Market
Barclays	HUBX	2015	$26 m	$6.7 m	Wealth Management, Payments, Financial Management Solutions
	Smart	2014	$871 m – $1.3b	$243 m	Wealth Management
	MarketFinance	2010	$739 m-$1.1b	$260 m	Mortgages & Lending
	Form3	2016	$640 m-$960 m	$217 m	Payments, Banking
	Block (former Square)	2009	$110b	$490 m	Payments (ML & AI)
	Shieldpay	2016	$26 m-$38 m	$12 m	Payments
	Spark Change	2018	$18 m-$28 m	$7.6 m	Wealth Management
	Neptune Networks LTD	2016	$60 m–90 m	$15 m	Trading
	H4	2015	$108 m-$162 m	$39 m	Legal Documents Management
	Stenn	2015			Mortgages & Lending
	Youtility	2016	$24 m-$36 m	$5.9 m	Financial Management Solutions (Mobile App)

(*continued on next page*)

Table A1 (*continued*)

	Flux	2016	$30 m-$45 m	$9.1 m	Payments, Financial Management Solutions (Big Data)
	Fnality International	2019	$264 m-$396 m	$66 m	Payments, Crypto and DeFi (Blockchain, Deep Tech)
	Bink	2014	$53 m-$79 m	$23 m	*E*-commerce Solutions
	Logic Group	1986			Payments
	Admiral Group	1993	$11.7b		Insurance
HSBC	Manolete Partners	2009			Insurance, Financial Management Solutions
	Quantexa	2016	$850 m	$243 m	RegTech (Big Data, ML, AI, Deep Tech)
	Divido	2014	$120 m-$180 m	$260 m	Payments
	Proactis	1996	$98 m	$217 m	Financial Management Solutions
	Neptune Networks LTD	2016	$60 m–90 m	$15 m	Trading
	Proxymity	2017	$82 m-$123 m	$12 m	Financial Management Solutions
	Cult Wines Ltd	2007			Wealth Management
	Visible Alpha	2012	$152 m–228 m	$15 m	Wealth Management (Big Data, Deep Tech)
	Bud	2015	$80 m-$120 m	$39 m	Banking (ML & AI)
	AcadiaSoft	2005	$120 m-$180 m	$57.7 m	Financial Management Solutions
Standard Chartered	Blue Motor Finance	2014			Financial Management Solutions, Mortgages & Lending
Lloyds Banking Group	Thought Machine	2014	$1b	$353 m	Banking (Deep Tech)
	Form3	2016	$640 m-$960 m	$217 m	Payments, Banking
	Embark Group	2016	$390		Wealth Management, Financial Management Solutions
	Fnality International	2019	$264 m-$396 m	$66 m	Payments, Crypto and DeFi (Blockchain, Deep Tech)
NatWest	Updraft	2017	$190 m-$285 m	$70.4 m	Mortgages & Lending, Banking
	RoosterMoney	2012			Financial Management Solutions (Mobile App)
	Wise	2011	$15.3b	$396 m	Payments
	Pollinate	2017	$462 m	$219 m	Payments, Banking
	Pynk	2018	$8 m-$12 m	$2.5 m	Wealth Management (Deep Learning, Big Data, Deep Tech, ML, AI)
	Quint Group	2009	$53 m-$79 m	$13.2 m	Mortgages & Lending
	Loot (Closed)	2015	$11 m-$16 m	$14.9 m	Banking (Mobile App)
Royal Bank of Scotland (RBS)	Swoop Funding	2018		10.3 m	Mortgages & Lending
	Tide	2015	$650 m	$272 m	Banking
	Starling Bank	2014	$1.7b	$964 m	Banking
	Cennox	2004	$16 m-$24 m	$35.6 m	Banking
	Modulr Finance	2015	$125 m	$82.4 m	Payments
	Atom Bank	2014	$211 m-$317 m	$601 m	Banking (Mobile App)
	Pollinate	2017	$462 m	$219 m	Payments, Banking
	iwoca	2011	$250 m	$95.5 m	Mortgages & Lending
	Expend	2014	$17 m	$2.1 m	Financial Management Solutions
	Fluidly	2016	$26 m-$40 m	$15.9 m	Financial Management Solutions (Deep Tech, ML, AI)
	Metro Bank	2010	$260 m	$686 m	Banking
	Loot (Closed)	2015	$11 m-$16 m	$14.9 m	Banking (Mobile App)
	FreeAgent	2007	$75 m	$4.3 m	Financial Management Solutions

Table A2
Models of engagement with FinTech firms.

Type	Description	Pros	Cons
Investment	Banks invest their own capital in FinTech start-ups as: dedicated in-house venture capital or strategic investment arms, independent venture capital funds or investments on their own balance sheet	Gains early access to innovative solutions; Resolves lack of in-house talent and innovative culture; Reduces time-to- market	Right valuation can be challenging; Monetization of investment; Misuse and mishandling of data by third parties; Not exclusive relationship Data security and privacy
Collaboration	Banks enter various types of arrangements with FinTech companies: utilizing FinTech products or platforms; Collaborating as a network to develop and test new technologies and solutions; Referral arrangements; Joint ventures or co-created services	Reconnects with customers without significant time and resource investment; Benefits cutting-edge projects such as blockchain; Addresses lack of in-house talent and innovative culture	Finding a compatible partner; Monetization of partnership; Data security and privacy Potential culture clashes; Not always an exclusive relationship
In-house development of products	Banks are accelerating their in-house development of FinTech products and services.	Exclusivity; Easily scalable; Better control on technology, talent and resources	Challenging given banks' traditional structures and legacy systems; Expensive to develop, maintain technology and hire specialists; Lack of in-house talent; Increased time-to-market; Strict regulatory and compliance environment
M & A	Acquiring a FinTech company can increase a bank's digital footprint and short-cut the development of new technology. This is typically banks' least preferred strategy, but we observe large global and regional banks taking stakes in online competitors.	Rapid route into new markets; Fast delivery/go-to-market; Exclusivity New customers at low cost–opportunity to cross sell; Market/product differentiation; Access to talent and innovative culture	Valuation can be difficult; Difficult to integrate due to cultural differences; Could lead to internal tensions; Retention of talent; Integrating new solutions into existing systems could accelerate costs
Joint FinTech program		Collaborative role with other banks alongside program participants Flexible to tailor staff's level of involvement according to resource capability; Cost shared with other parties Mentorship program sponsorship opportunities that provide enhanced FinTech network	Limited branding opportunities (as these are shared with others) Potentially low financial ROI if small minority stakes are shared with others Involvement may be viewed as tokenistic
Lead FinTech program		Ability to control program scope, set exclusive partnership terms and first-mover advantage on	Requires dedicated team as interface between program managers and internal departments, and

(*continued on next page*)

Table A2 (*continued*)

Type	Description	Pros	Cons
		successful ideas ROI potential from tailored solutions and first user of innovation solutions	senior management requirements Budget required to support resourcing for each program cycle

Source: EY (2019).

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