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## Article

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Digital Business

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*Suggested Citation:* Barroso, Marta; Laborda, Juan (2022) : Digital transformation and the emergence of the Fintech sector: Systematic literature review, Digital Business, ISSN 2666-9544, Elsevier, Amsterdam, Vol. 2, Iss. 2, pp. 1-18,  
<https://doi.org/10.1016/j.digbus.2022.100028>

This Version is available at:

<https://hdl.handle.net/10419/337904>

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# Digital transformation and the emergence of the Fintech sector: Systematic literature review

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## ARTICLE INFO

### JEL classification:

G20  
G21  
G23  
G30  
L26  
O33

### Keywords:

Fintech  
Regulation  
Banking  
Digital transformation  
Systematic literature review  
VOS viewer

## ABSTRACT

This paper provides an analysis on the emergence of new technologies in the financial industry and their application to financial and investment activities, where organizations are highly equipped with the technology needed to overshadow traditional financial institutions. In addition, three of the most important and controversial areas of this sector -challenges, regulation and collaboration- are reviewed and analyzed in depth through a systematic literature review. VOS Viewer software has been used to classify the different keywords, according to their co-citation, following clustering techniques. Thanks to the studies carried out by other researchers, it has been possible to structure clearly the distribution and trends in the financial sector, mentioning also possible future trends and gaps to be researched in the sector.

## 1. Introduction

This document provides a broad view of what changes the financial industry is undergoing and how it might look in the future. It is intended to offer the current state and perspectives of the financial sector on the main issues it covers. The study is motivated by the high degree of innovation and interest in the development of new products and services in the digital field, and those related to the financial sector. These innovations are quite recent, being the reason of the upsurge of so many doubts and challenges for researchers, economists and regulators (Milian, Spinola, & de Carvalho, 2019).

Due to the speed of today's technological advances, the Fourth Industrial Revolution is currently disrupting nearly every industry in every country. The scope and extent of these changes involve the transformation of entire systems of production, management and governance (Xu, David, & Kim, 2018). Therefore, the Fourth Industrial Revolution brings as a result a massive use of the Internet, social networks, digital devices, etc. The result, regarding the scope of this study, is a greater diversity in the form of new business models in the provision of financial services. The outcome is the emergence of a new set of companies, which

are entering the market (known as Fintech), taking advantage of this digitization, in order to provide financial products and services. Fintech firms are start-up companies willing to disrupt the financial industry by providing services and products involving digital platforms and using advanced technology (Wang, Xiuping, & Zhang, 2021). They emerged as an alternative to traditional banking in response to the gap left by banks during the 2008 financial crisis; experiencing an annual growth of 46.5% since its appearance (Fung, Lee, Yeh, & Yuen, 2020). These new players, among other effects, facilitate access to the digital financial world, provide more specialized services focused on client needs, are flexible and agile, and boost innovation and competition throughout the financial industry. The outcome, according to Weller and Zulfiqar (2013), is a higher economic and financial stability, although they also pose new challenges and solutions in this sector, which will eventually be discussed.

Our main aim on this paper is to analyze the current situation of the financial sector, regarding all the agents that constitute the sector. The study proposes to structure and analyze the available academic literature by carrying out an exhaustive academic research on the scope of digital finance. It is intended to identify new directions and

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opportunities in the field, in order to clarify the main questions raised by academics: How regulated is the Fintech sector? What kind of challenges do Fintechs and the digital financial sector face? What mechanisms do banks and Fintech have to survive in the long term? Will these platforms cooperate with traditional operators to share services? By trying to respond to the main questions, this paper aims to contribute to banking literature by forming an empirical basis for future studies.

The paper is structured as follows: Firstly, the work provides a literature review of the digitization process of the financial sector and its functionalities. It covers a brief introduction of the digital transformation at the sector, the appearance of Fintech firms, and their goals and functions. It also focuses on describing the new business models that are being undertaken, as well as the emergence of large technological companies (Bigtech). Finally, information is given on the different technologies used, such as machine learning or robo-advisors, which could potentially reinforce the different business models (Fung et al., 2020).

Next, the proposed methodological framework and the obtained results are detailed. The research design is conducted through a systematic literature review, where the obtained results are presented after an exhaustive and quantitative analysis of the literature available in different databases, using clustering techniques via Vos Viewer. The activities of Fintech companies raise several questions about the level playing field between these firms and banks, in terms of regulation, competition assessment and cooperation (Gai, Qiu, & Sun, 2018). As a result, the performed analysis is based on three key issues concerning this sector: regulation, challenges and collaboration. It consists of researched academic articles based on a predetermined list of keywords, which are searched for in a shortlist of high-profile international conferences and journals. Afterwards, the core results of the analyzed research are described systematically. In addition, the identified articles are catalogued in different figures that allow obtaining a complete summary of the identified academic research in the area, thus we can identify most research gaps, which provide a basis for discussion of future research directions. Finally, the main conclusions are summed-up, aimed at answering the key questions of this paper.

## 2. Literature review

### 2.1. The digital financial sector and its transformation

Data on Fintech investment reveals its dramatically rapid increase over the last years and, consequently, there has been a considerable increase in academic literature on the subject, mainly from 2015 onwards (Zavolokina, Dolata, & Schwabe, 2016a, 2016b). According Accenture (2016), overall Fintech in Europe investment doubled (120%) between 2014 and 2015 and the number of deals increased by 51%. On the other hand, in Asia-Pacific, investment more than quadrupled in 2015 to \$4.3 billion, with most of those investments taking place in China (\$1.97 billion) and India (\$1.65 billion). Fintech investment in North America grew 44% to \$14.8 billion in 2015, and the U.S. continued to dominate the sector with 667 Fintech deals, an increase of 16%.

Terms like ‘digital innovation’ or ‘digital transformation’ are used in numerous researches in order to try to identify innovations and disruptions. Digital innovation is defined as “a product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT” (Fichman, Dos Santos, & Zheng, 2014). Additionally, according to Guellec and Paunov (2017) “digital transformation is the digitization of previously analog machine and service operations, organizational tasks, and managerial processes”. The crossing point between IT and finance is known as Digital Finance, which describes the digitalization of the financial industry (Gomber, Koch, & Siering, 2017).

However, the Digital Finance field has experienced a continuous change, which Arner, Barberis, and Buckley (2015) explain in three

different stages. During the first stage (1866–1967), globalization allowed financial interconnections, payments and other financial transactions to cross borders between countries. Furthermore, the stage ended in 1967 with the invention of the first ATM, where the world saw finance and technology combined for the first time. In the second stage (1967–2008), the first credit cards also appeared and SWIFT messages were created (system enabling interbank financial transactions), thus the first sign of online banking appeared. Finally, in the third stage (2008-onwards) the process of digitization rapidly changes into a path where firms start to use innovative technology in their processes. Being technology the main driver, new start-ups start to appear in the financial industry, known as Fintech, as an alternative to traditional banking in response to the gap left by the banks during the 2008 financial crisis.

### 2.2. What is Fintech?

Nowadays, the use of technology is essential, but, what exactly is technology? Technology is a fundamental pillar for the economic, social and cultural development of the society. It is understood as the application of materials, tools and new processes to the different activities, which are daily done. A report conducted by the World Economic Forum (2015) stated that it is not possible to avoid innovation derived from technology.

In order to understand change in the financial sector in a more comprehensive view, Hanelt, Bohnsack, Marz, and Antunes Marante (2021) define digital transformation as an organizational and continuous change that can be triggered and shaped by the generalized diffusion of digital technology. This continuous change shows that recent technological activity in the financial industry has led to the entrance of new agents in the market, known as Fintech. The term comes from the association of the words Finance and Technology. Researchers in the field have come up with different definitions for this term. According to the Financial Stability Board (FSB), Fintech firms are described as “technologically enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on financial markets and institutions and the provision of financial services” (FSB, 2017a, 2017b). The Organization for Economic Co-operation and Development describes Fintech as “innovative applications of digital technology for financial services” (OECD, 2018). On the other hand, it can be referred to as “innovators and disruptors in the financial sector that make use of the availability of ubiquitous communication, specifically via the Internet and automated information processing” (Gomber et al., 2017). The definition can still be nowadays ambiguous, but it can be stated that they are mostly start-ups assuming the paper of traditional financial institutions bringing new business models into the industry. They appeared in the middle of the financial crisis, and they emerged as an alternative to traditional banking. It was then when Fintech firms appeared and filled in the gap left by banks, leading to a massive increase in global investments in Fintech ventures from USD 4.05 billion in 2013–12.21 billion in 2014 (Skan, Dickerson, & Masood, 2015). Overall, the introduction of Fintech firms has led to an increase in economic growth and apparently in financial stability. Moreover, established firms in IT sectors are striving to enter this scenario, acting as active financial service providers (OECD, 2018).

Traditional banks have seen themselves in a position with augmented pressure where Fintech firms apply innovative technology to offer commercial and corporate banking products and services raising customer experience. These financial innovations can be classified as; new products/ services, new production processes/ new organizational forms (Frame & White, 2014). This paper will be more focused on the first two.

Table 1 displays the main business functions in Digital Finance, which are the ones that are affected by the potential of new technologies and services. It includes the relevant literature, in order to understand better the digital transformation of the sector, following the scheme

**Table 1**  
Fintech main business functions.

Business function	Description	Academic articles
Payment services	<p>This rapidly growing function can be defined as “all payments that are initiated, processed and received electronically” (Hartmann, 2006). Adopting digital payments has numerous advantages for consumers, offering convenience and speed. Unlike traditional transactions, new payment services discourage theft and other cash-related crimes (Rahman, Ismail, &amp; Bahri, 2020). Digital payment solutions encompass various and innovative forms of payment where the Internet acts as an ‘intermediary’ between the bank and the customer:</p> <ol style="list-style-type: none"> <li>1. Mobile banking is the access to banking services via a mobile phone and it is an e-payment subcategory.</li> <li>2. Peer-to-peer (P2P) payments are as well attached to digital payments, allowing payments between private individuals.</li> <li>3. Another relevant and innovative concept is e-wallet, which “is a payable device without the use of cash or money” (Subaramaniam, Kolandaisamy, Jalil, &amp; Kolandaisamy, 2020).</li> </ol> <p>There is a surge of online platforms matching lenders and borrowers. Online funding platforms are known as crowdlending or crowdfunding. The main idea is raising funds through the provision of small credits by small investors in an online platform. There are different classes of crowdfunding platforms; debt and equity crowdfunding, donation-based crowdfunding and reward crowdfunding. The emergence of financing via online platforms has decreased transaction costs, enabling the financing of small businesses, therefore increasing financial inclusion.</p> <p>‘Insurtech’ is used to refer to those firms operating in the insurance industry using the latest technology. There are no further motivations for research, since there are not many important disruptions. Instead, there are improved existing insurance products and services. Another assertion is that Insurtech firms have entered the market by collaborating with incumbents rather than replacing them. Robo-advisory disruptions in the insurance sector are the emerging innovators, being capable of lowering costs while increasing quality and transparency.</p> <p>Digital investment means making investment decisions in new assets, securities, commodities, etc. or the management of a portfolio using technological devices. This business function includes:</p> <ol style="list-style-type: none"> <li>1. Mobile trading: way for investors to invest and manage portfolios via mobile devices anywhere and anytime.</li> <li>2. Social trading: it “allows making investment decisions based upon information gathered in online communities” (Doering, Neumann, &amp; Paul, 2015).</li> <li>3. Online brokerage: means giving the same services as traditional brokers but via online. Therefore, they are independent from time and place.</li> <li>4. High frequency trading (HFT): it falls under the B2B context. It is understood as “investors using computers to trade securities over extremely short time intervals”. (Biais and Foucault, 2014)</li> </ol>	<p>Munir (2004), Hartmann (2006), Dahlberg, Mallat, Ondrus, and Zmijewska (2008), De Bel and Gáza (2011), Contini, Crowe, Merritt, Oliver, and Mott (2011), Bradford and Keeton (2012), Zulhuda (2012), Shetty, Shetty, and Amale (2014), Gao and Waechter (2017), EY (2017), FSB (2017a, 2017b), Gomber et al. (2017), World Economic Forum (2017), Subaramaniam et al. (2020), (Rahman et al., 2020)</p> <p>Chircu and Kauffman (2000), Berger and Gleisner (2009), Belleflamme, Lambert and Schwienbacher (2014), Allison, Davis, Short, and Webb (2015), Burch and Chan (2014), Morse (2015), FSB (2017a, 2017b), Gomber et al. (2017), Hudon, Labie, Szafarz, and Eds.). (2019)</p> <p>Chuen and Deng (2017), Gomber et al. (2017), IAIS (2018), Chen (2018), S&amp;P (2018), Baker and Dellaert (2017), Deloitte (2018), Stulz (2019)</p> <p>Barber and Odean (2002), Bouwman, Carlsson, Molina-Castillo, and Walden (2007), Lechner and Nolte (2007), Lee (2009), Lattemann et al. (2012), Tai and Ku (2013), Zhang and Teo (2014), Biais and Foucault (2014), Doering et al. (2015), Gomber et al. (2017)</p>
Credit and lending		
Insurance services		
Investment management		

presented by Gomber et al. (2017).Table 2)

### 2.3. Bigtech

The literature on this topic suggests that this market segment is mainly recent. It is important to know these companies from a financial point of view, since their popularity is more addressed (related to) to the IT sector. The term Bigtech comes from the association of the words Big and Technology. They are a group of technological companies provisioning direct financial services (Frost, Gambacorta, Huang, Shin, & Zbinden, 2019). Others, like Zetzsche, Arner, Buckley, and Tang (2020), refer to them as Techfin (union of Technology and Finance). According to a McKinsey report, Bigtech firms could reduce the banking industry’s RoE by around four percentage points to an “unsustainable 5.2%” by the year 2025 (McKinsey., 2015).

The main difference between the two groups of firms is that technology, and not finance, has become the Bigtech’s main driver (Carstens, 2018), although they provide almost the same services as Fintech: payment services, insurance, credit, and investment/ wealth management.

Given their size, they rely on data analytics, which provides them with a competitive advantage against the rest of their competitors of the market. Being access to data the main fundamental asset of a company (Petersen, 2004), Bigtech have the competitive advantage of managing the required information from their customers in order to provide financial services. Having access to all this information acts as a higher barrier to entry (Hauswald & Marquez, 2003), increasing interest rates and firm’s profits.

On the other hand, Bigtech companies can act in the market as a marketplace or as a reseller (Hagiú & Wright, 2015). The marketplace sells the products or services directly to the final customer whereas the reseller acts as a middle intermediary, buying the products from suppliers and selling them to the customers. In the former case, Bigtech firm gives the option to engage with incumbent financial institutions through their channel, benefiting from network effects (De la Mano & Padilla, 2018). In the latter case, it acts as a reseller when it raises funds lending them to the consumers. In addition, De la Mano & Padilla (2018) talk about the monopolization of the credit market, where banks would simply fund Bigtech loans. If this were the case, it would harm consumer welfare directly affecting competition and financial stability.

**Table 2**  
Digital finance technology.

Digital finance technology	Description	Academic articles
Artificial Intelligence	<p>Artificial intelligence can be described as a set of technologies that can simulate human actions in technological devices that have been previously taught without any new intervention (Buchanan, 2019).</p> <p>A related technological concept is Machine learning (ML), which is a set of algorithms that can predict new scenarios, with the approaches previously given. Chakraborty and Joseph (2017) indicate the applications of ML in the banking system. For example, understanding the evolution of mortgage contracts is crucial for the performance of the financial institutions' balance sheets. On the other hand, algorithms may be used in predicting purchase patterns of current customers in order to advise them more precisely.</p> <p>Finally, Chakraborty and Joseph (2017) present different models used, as Artificial Neural Networks or Genetic Algorithms, which are both algorithms inspired in the functioning of the human brain. Helbing (2019) refer to these as the emergence of a new label, called "Cognitive Computing". It is also interesting to mention the research conducted by De Prado (2018), where he states that most hedge funds conducting machine learning techniques to financial datasets fail due in part to the belief that ML can be used as a panacea.</p>	<p>Wuerges and Borba (2009), De Prado (2018), Chakraborty and Joseph (2017), Buchanan (2019), Helbing (2019)</p>
Big Data	<p>A related field is Big data, which is "data whose size forces us to look beyond the tried-and-true methods that are prevalent at that time" (Jacobs, 2009). In a simpler way, it "describes the massive quantities of data generated and collected in commercial transactions and other events" (Barr, Koziara, Flood, Hero, &amp; Jagadish, 2018).</p> <p>Big Data analytics refers to the application of analytical methods to large amounts of data sets. These data sets are outlined regarding the "Four V's Dimension" (Volume, Variety, Velocity, Veracity). Banks or Fintechs rely on their customer's past data or even current determinants not directly related to creditworthiness (Hurley &amp; Adebayo, 2016), for determining their credit scores. Gepp, Linnenluecke, O'Neill, and Smith (2018) give an analysis of the big data techniques used in different areas of finance and auditing. They reveal that financial failure and financial fraud modeling, stock market prediction and auditing, are the main domains of Big Data usage in finance.</p>	<p>Jacobs (2009), Hurley and Adebayo (2016), Barr et al. (2018), Gepp et al. (2018)</p>
Distributes Ledger Technology	<p>Blockchain is a digital system that enables recording transactions in a decentralized distributed ledger. It is decentralized since any authority or institution do not regulate it. It is considered a "trust machine" (Wang, Bellavitis, &amp; DaSilva, 2018) since it relies on the work of all the constituted networks of the platform and all the transactions are recorded and available in the blockchain. Consequently, a hacker would have to change all the blocks, making cyberattacks almost impossible.</p> <p>The most important ramification of the blockchain is cryptocurrencies or digital currencies presented in 2008 by Nakamoto (2008).</p> <p>There are numerous literature reviews regarding different applications of blockchain in the financial industry. For instance, Hellwig and Huchzermeier (2019) provide a discussion of the potential risks and opportunities regarding the use of this technology in the trade finance area. On the other hand, authors like Mills et al. (2016) or Caytas (2016), provide similar approaches on how the payments, clearing and settlement area could be disrupted by this technology.</p>	<p>Nakamoto (2008), Mills et al. (2016), Caytas (2016), Crosby et al. (2016), Wang et al. (2018), Hellwig and Huchzermeier (2019), Vontobel (2019)</p>
Smart Contracts	<p>Blockchain could reduce operational and transaction costs, and financial inefficiencies. In addition, incumbent financial institutions are starting to implement this technology into their operations. In addition, blockchain technology can be applied in other areas of the financial industry, having some further applications as well outside this sector (Crosby, Pattanayak, Verma, &amp; Kalyanaraman, 2016).</p> <p>Interestingly, smart contracts could be implemented in DLTs. Smart contracts are "a set of promises that are agreed on between parties, encoded in software, and executed automatically when agreed-upon criteria are met" (Hellwig &amp; Huchzermeier, 2019).</p> <p>These types of contracts could make even simpler operations and transactions in blockchain. They allow more traceable, transparent and irreversible transactions from both a legal and technological point of view. According to Brammertz and Mendelowitz (2019), smart contracts could replace, under some standards, almost any financial contract due to their mathematical nature.</p>	<p>Arner et al. (2015), Hellwig and Huchzermeier (2019), Brammertz and Mendelowitz (2019)</p>
Cloud Computing	<p>Wireless connections have increased their popularity over the business sector. Cloud computing has been subject of numerous researches and all of them have come to the point where its definition is wide and complex. It can be studied from a technical point of view or from a business one, but one thing is certain; it has revolutionized traditional business models and value chains.</p> <p>Every activity is held virtually, which makes it easier for organizations to enter a global market without the necessity for a physical structure (Rossi, 2014). Therefore, it can be defined as; "an information technology service model where computing services are delivered on-demand to customers over a network in a self-service fashion, independent of device and location" (Marston, Li, Bandyopadhyay, Zhang, &amp; Ghalsasi, 2011).</p> <p>On the other hand, Near Field Communication (NFC) is a wireless system that enables two technological devices to communicate when they are close to each other. It is a very intuitive and simple system since it works just by "touching smart objects" (Nagashree, Rao, &amp; Aswini, 2014). This technology is widely used daily, since it enables making payments with credit or debit cards, or even mobile devices, when</p>	<p>Leimeister, Böhm, Riedl, and Krcmar (2010), Rossi (2014), Marston et al. (2011), Nagashree et al. (2014)</p>

(continued on next page)

Table 2 (continued)

Digital finance technology	Description	Academic articles
	near a cash desk NFC device. In this form, the payment is immediately transferred to the payee.	
Robo-advisors	<p>Lastly, financial advising services demand are highly increasing. This technological service extends to investment, credit and insurance. It is optimal to refer to it as robo-advisor or financial advisor. They are mentioned as a technological and automated service that gives investment and management advice without the interface of a human advisor. They match clients with the financial products by asking several questions through a questionnaire. However, questionnaires given by robo-advisors have been questioned, since it is not fully certain if they gather all the necessary information in order to meet the customer's "best interest" (Fein, 2017).</p> <p>The fact that algorithms will not behave in the consumer's ultimate goal, makes them being in the spotlight for regulators and policymakers. Nevertheless, if honesty and transparency is assumed, financial advisors accelerate the process of investment resulting in lower costs and higher speed (Baker &amp; Dellaert, 2017), avoiding conflicts of interests.</p>	Fein (2017), Baker and Dellaert (2017), Schoeff (2015)

Examples, widely known, are some US based firms, such as Google, Amazon, Facebook or Apple (commonly known as GAF A) and the Chinese firms Tencent or Alibaba. Interestingly, Stulz (2019) and Carstens (2018) compare both types of markets, making a special mention to Ant Financial.<sup>1</sup> Their research shows that the US market is falling behind the Chinese one, although reasons are not yet still clearly enough; it may be due to the payment mobile system consumption of China, which represents 16% of its total GDP, or because there is a more limited development of payment services in the United States, due to the widespread use of credit and debit cards (Frost et al., 2019). However, World Bank (World Bank, 2018) analyzed that 82% of the unbanked population in China owns a mobile device, representing a market opportunity for Chinese Bigtech firms.

#### 2.4. Digital finance technology

By 2013 there was evidence that many of the jobs carried out today would be automated; "almost 47% of the current jobs will be at risk" (Frey & Osborne, 2013). However, digital technologies are not the centerpiece of digital transformation, as the key is the combination of these technologies together with a business logic that allows transforming a business into a digital business (Hanafizadeh & Kim, 2020).

This section encompasses some of the different technological concepts used by incumbents and Fintech firms in order to carry out their business functions. The main technologies that will be discussed are: artificial intelligence and machine learning, big data, distributed ledger technology, cloud computing, robo-advisors and smart contracts. See Table 2.

Besides these financial concepts, it is important to mention that there are other technologies, which are as well used. Examples include security technology, social media or technological devices.

### 3. Methodology

#### 3.1. Methodological framework

The following study is an up-to-date, comprehensive and cutting-edge review, which has been performed in order to present the work conclusions and gaps for future researches, of some of the most important issues in the financial sector, according to several global organizations and institutions (Feyen, Frost, Gambacorta, Natarajan, & Saal, 2021). A Systematic literature review will be provided in order to cover

<sup>1</sup> Ant Financial is an affiliated company of the Chinese group Alibaba. Ant Financial is the highest valued Fintech firm in the world.

all the literature related to Digital Finance regulation, collaboration between Fintech firms and incumbent financial institutions, as well as current challenges and future directions. Following the definition by Okoli (2015), a systematic literature review is "a systematic, explicit, [comprehensive,] and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners". Reviewing the current literature allows understanding the breadth and depth of existing articles as well as to identify potential gaps to be explored. By summarizing, analyzing and synthesizing the literature related to a specific topic, hypothesis can be tested and/or new theories developed (Xiao & Watson, 2019).

The literature review will follow a similar structure as proposed by Tranfield, Denyer, and Smart (2003) and Xiao and Watson (2019). The process is divided into five phases, as shown in Fig. 1.

Phase 1 is key to set the direction of the analysis carried out. It defines the goal, the research area and scope to be used for the search and analysis of academic papers. This has been done because regulators and policymakers in the finance sector must overcome many challenges due to new technological innovations in the field, being pertinent to address them jointly. Regarding collaboration, the main idea is trying to find the different partnerships among institutions in order to defeat the challenges and obstacles of the sector. These are the main goals of the literature review. Therefore, the research area is academic literature on regulation, collaboration and challenges. Finally, a research scope must be established since it is not possible to use all the literature available. However, a scope is defined in order to select the most relevant academic papers in order to do a more critical analysis and capture the most recent information available.

Phase two is to define the criteria by which academic papers are selected, for better provision of important results and conclusions. For this research, academic papers dating from 2008 to 2020 will be used. This period range is considered because the Digital Finance revolution started in the financial crisis of 2008, when Fintech start-ups started to emerge, as stated in the literature review. Additionally, using a period range higher than 12 years would hinder the purpose of this analysis since it would not evaluate all the important details. Besides, different online databases have been used for the literature review. A database is "an organized collection of structured information, or data, typically stored electronically in a computer system" (Oracle, 2020). To conduct this research, different databases of academic papers have been used: International Bureau of Economics; Scopus; Google Scholar; Emerald; Semantic Scholar; and Science direct.

Some of these databases include high quality academic journals, which are used as well. This leads the work into phase 3, which the aim is to classify the selected articles according to specific criteria. If an

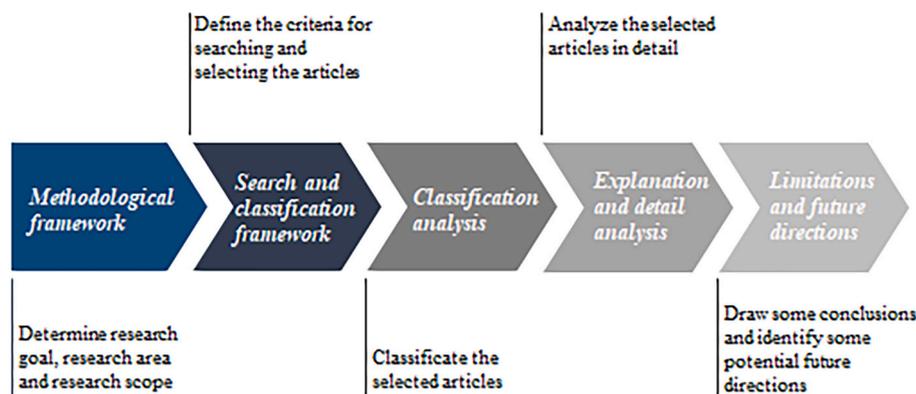


Fig. 1. Phases of the literature review.

academic journal or article was not available or free in any of the databases, the corresponding academic journal website has been used. A criterion has been implemented in order to select the articles in the different journals and databases. This research is focused on articles and journals published in the SCImago Journal & Country Rank. It is a research group formed by several institutions and universities (Sci-mago). They give a ranking indicator to each journal, according to a mathematical formula. The higher the indicator, the higher the journal will be in the ranking list. According to the research area of the analysis and the information provided by the ranking website, two subject areas have been selected: (i) Economics, econometrics and finance, and (ii) Business, management and accounting. In order to reach the final purpose, each article was fully and critically examined, and the ones that were fully available and finished were used.

The selection of the academic papers was carried out following a list of keywords (keywords of the bibliographic publications should be filtered to define the field of research) based on the three research areas. See Table 3. In order to ensure veracity, as stated in Gomber et al. (2017), the keywords must appear in the title, abstract or keywords section of the corresponding article. What is more, some articles were excluded when the topic did not match the research area. For example, an article addressing the different and current bank regulations does not match the research goals.

The application of scientometrics can provide new and deeper information on the topics to be addressed. The use of scientometric techniques provides both a clear understanding of the evolution of previous literature and helps to identify new areas of study (Hanafzadeh and Marjaie, 2020). According to Chen, McCain, White, & Lin (2002), co-word analysis and co-citation analysis are among the most fundamental techniques for scientometrics and science mapping. Co-citation and cluster analyses based on scientometrics provide objective and quantitative approaches to identify the core knowledge and academic networks in specific fields (Liu, Li, Shen, Yang, & Luo, 2018). In order to carry out a deeper analysis and to observe the methodological coherence approach, the technique of keyword co-citation (Braam, Moed, & Van Raan, 1991) is used. When two or more keywords on a specific research topic appear in the same thesis, they have essential relationships. The greater the co-occurrence between two keywords, the closer their relationship (Chen, Chen, Wu, Xie, & Li, 2016). The co-citation of keywords in research units of different levels establishes the relationships between papers, authors, countries, etc. (Su & Lee, 2010).

Cluster analysis has typically been used in traditional co-citation analysis. In a traditional co-citation study, usually publications or authors are grouped together, and then efforts are made to characterize the nature of the major clusters as substitutes for the specialties (Chen, McCain, White, & Lin, 2002). In this sense, to carry out network visualization, VOS Viewer software is used for classifying the keywords according to their co-citation.

Table 3  
Keywords of the different research frameworks.

		Keywords
Frameworks	Regulation	Digital banking regulation, Fintech regulation, regulatory Fintech institutions, digital payment regulation, Crowdfunding regulation, Blockchain regulation, Regtech, Fintech regulators, Insurtech regulation
	Collaboration	Fintech collaboration, Fintech partnerships, Bank partnerships, Fintech integration
	Challenges	Fintech challenges, Banking challenges, Digital finance challenges, Future banking challenges, Bigtech challenges, Fintech risks

Finally, in phases 4 and 5, the selected papers are analyzed in depth, their contents are explained and conclusions are drawn to generate a simple roadmap for researchers who wish to better understand this field.

### 3.2. Search and classification framework

As explained above, in the second phase, it is important to define the selection criteria and data filtering for the articles, according to the table of keywords previously inserted. In order to do this, a data selection and filtering process has been conducted, see Fig. 2, as stated in the literature review done by Ngai, Hu, Wong, Chen, and Sun (2011).

Each article has been carefully and critically examined in order to avoid any biases at the end of the analysis. Therefore, unpublished or articles that are still in research were excluded. Articles expressing opinions or subjective hypotheses were also excluded since clarity, brevity, accuracy, and reliability must be of crucial importance when conducting an analysis (Hart, 1998).

Considering all these assumptions, 193 articles were used. In total, 330 papers were potentially identified. However, considering the first verification process, 89 articles were eliminated, being 235 the total number of articles left to review. Out of these, 48 articles were duplicated, since databases often publish the same articles.

## 4. Empirical results

### 4.1. Classification analysis

In conclusion, a sum of 193 articles were screened, including both articles and conferences from academic journals, according to the process previously done. It is interesting to observe the evolution of

publication of articles throughout the period chosen, which is described in Fig. 3.<sup>2</sup> The graph shows that, almost until the year 2014, not many articles about regulation were published. Moreover, it was not until 2015 when the challenges and the collaboration issues were not addressed in academic journals. From these years on, articles began to rise and in the year 2017, the number of published articles for regulation had its peak, with 25 in total. For collaboration and challenges for the sector, its peak for published ones was among the years 2018–2019, with 5 and 13 papers, respectively. On the other hand, the first identified paper for regulation was in 2010, and for collaboration in 2016. However, the first article addressing the challenges was published in 2008, although in 2009, 2011 and 2012, no articles were identified.

Fig. 4 illustrates the three different research areas according to the different keywords used in the search phase. The different graphs show the density of the publications according to each keyword. It can be observed that, for instance, zero articles were found for bank partnerships, as all of them addressed topics outside the research scope. They mention several partnerships among different banks, but not between Fintech firms and banks, which is the main goal, although these partnerships currently exist.<sup>3</sup>

Additionally, following phase 3 of Fig. 1, another method of classification has been chosen to visualize in a broader way the relationship between the selected articles. For this purpose, a database has been used to classify the different keywords according to their co-citation, following clustering techniques. In this sense, VOS Viewer program is used, where VOS stands for “visualization of similarities” (Heersmink, van den Hoven, van Eck, & van den Berg, 2011). There are numerous computer programs that are used for bibliometric purposes. Among them, there can be distinguished several functionalities such as “temporal, geospatial, topical and network analysis” (Milian et al., 2019). However, the VOS Viewer program focuses more on the graphical representation of bibliometric maps, using special labeling algorithms, zooming or density metaphors (Van Eck, Waltman, Dekker, & Van Den Berg, 2010). It is used in order to create maps based on network data and to visualize and explore these maps. “It can be used to build networks of scientific publications, scientific journals, researchers, research organizations, countries, keywords or terms. The elements of these networks can be connected by means of co-authoring, co-occurring, citation, bibliographic linkage or co-citation links” (Durana et al., 2020). In this systematic literature review, the software constructed a map based on the co-citation frequencies of the different keywords. To make it clear, the software works with different databases; Web of Science, PubMed, Scopus, CrossRef JSON and RIS. Therefore, the software has only analyzed the academic articles of the Scopus database, since it is within the list of this analysis. In this way, the results of the VOS Viewer would be a sample of the complete literature review.

In order to analyze the results, it is important to understand how the maps work. As explained in Van Eck et al. (2010), the software’s objective is to place objects in a low dimensional space, so that the distance between any two objects reflects the similarity or relationship of the items as precisely as possible. In mapping, it has been shown that the mathematical approach followed by Waltman, Van Eck, and Noyons (2010) is equivalent to the VOS mapping technique carried out by Van Eck et al. (2010). In this sense, mathematically it is shown that the greater the association strength of two nodes, the greater the force of attraction between them. Since the repulsion force between two nodes does not depend on the association force of the nodes, the aggregate effect of the two forces is that nodes with a high association force are attracted to each other, while nodes with a low association force are

pushed towards each other (Waltman et al., 2010).

On the other hand, different colors are assigned, so that each cluster is represented by a different color. This means that the objects within the same cluster have more similarities than the objects in a different cluster. The different objects are also connected to each other by lines, which represent the linkages among them.

In order to follow the order of the analysis, three different maps were displayed, according to the three different groups analyzed: Challenges, Regulation and Collaboration.

Fig. 5 analyzed the keywords co-citation among the Fintech Challenges, displaying a total of 188 items and 9 different clusters, which includes the largest number of items among the three maps. The first one, consisting of 72 objects, included keywords such as banking crisis, banking regulation, default, policy maker, resilience or systemic risk. The second cluster is made up of 53 items and gathered items like big data, cloud computing, machine learning, m-banking, security, vulnerability, etc. The third cluster is formed by 28 keywords (bitcoin, blockchain, crowdfunding, Fintech, future research, P2P, smart contract...), and the fourth comprised 10 items (customer satisfaction, regulatory change, competitive advantage, etc.). Cluster number five and six are formed by 7 keywords each one, such as optimization, mitigation or operational risk (cluster 5), and inclusion or leadership (cluster 6). Cluster number seven is made up of six different items; financial performance, Pakistan or Malaysia. In the eighth cluster, there were 4 items, including rapid development and digital economy, and the last cluster, number nine, was only formed by one keyword (Turkey). The result of this figure summarizes how the banking sector along with Fintech companies are closely related. In addition, it shows how the three most important clusters in the figure summarize and interconnect the main challenges, such as regulation, together with the technology derived from the sector.

The Regulation clustering map is shown in Fig. 6, including 10 clusters and 121 items. The first cluster grouped 47 items like competition, financial regulation, consumer protection, supervision or financial stability. The second one, formed by 41 keywords, included items like blockchain, data protection, algorithm, bitcoin, smart contract, machine learning, cloud, control... Less than 10 items only formed the rest of the clusters. For example, the third and fourth ones are made up of 8 keywords each one, including digital currency, jurisdiction or payment system (cluster 3) and digitalization, legal regulation or digital economy (cluster 4). The fifth cluster contained 6 items, such as action, self-regulation or collaboration, and the sixth one included 4 keywords (ICO, success, token...). Cluster number seven involved 3 items like P2P or policymaker, and the eighth only had 2 different keywords (effectiveness and outcome). The last two clusters, number nine and ten, were only made of 1 item each one; technological innovation and artificial intelligence, respectively. The result of this figure indicates the most cited keywords in terms of regulation. It is interesting to see how blockchain is one of the strongest words. However, when analyzing this topic in depth, blockchain lacks strict regulation, compared to other business models. Moreover, it is interesting to see that all cluster words are related to innovation and technology, suggesting that new regulatory trends should follow the same path.

Fig. 7 shows the cluster map regarding Collaboration, according to the Scopus database. There were 78 items, the lowest number with respect to the other two maps, with eight clusters. The first cluster is composed of 37 keywords, including advantage, adoption, integration, innovation, Fintech, regulation, etc. 18 items, with keywords such as Africa, cooperation, monitoring, control or local government, formed the second cluster. The third cluster contained 10 items (future, interaction, power, agreement, etc.) and the fourth one comprised 5 keywords (failure, financial crisis, reform...). Finally, the last four clusters included 3, 2, 2, and 1 keyword, respectively. Cluster number five included keywords such as Indonesia and uncertainty. The sixth (economic growth and policy maker), the seventh (private company, transformation) and the eighth (absence), were the clusters with the least

<sup>2</sup> The graph’s period is 2008–2019 because it would not be accurate to include the current year (2020) since it has not finished yet. However, they have been used for this project’ analysis.

<sup>3</sup> An example of a partnership involves the German bank N26 with the Fintech Mambu, in order to use its cloud-based platform. (Mambu)

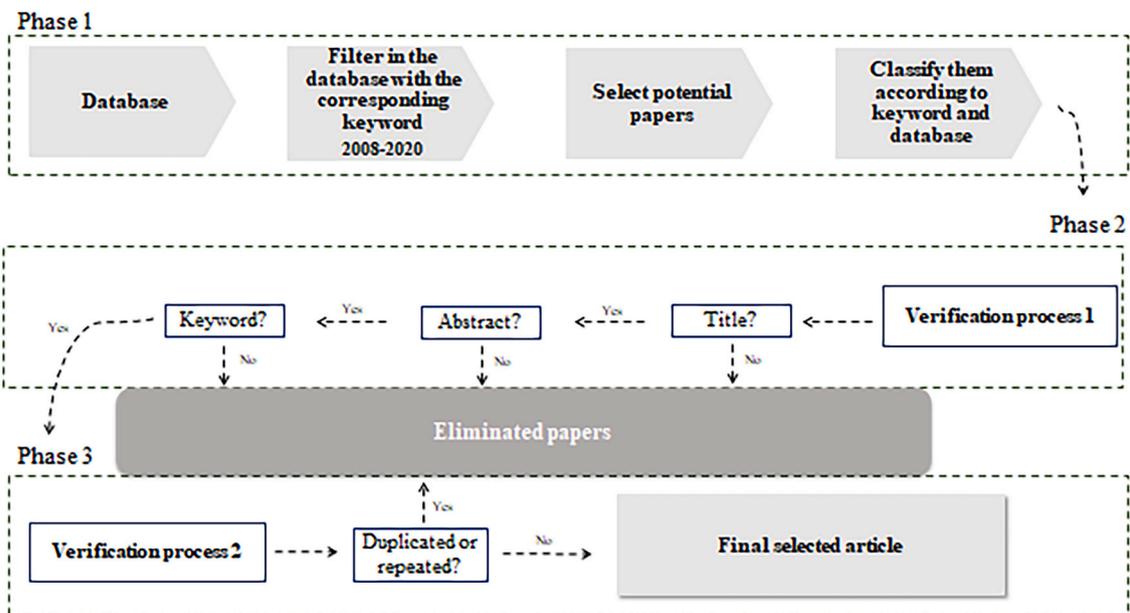


Fig. 2. Data selection and filtering process.



Fig. 3. Evolution of the three different categories (2008–2019).

number of items. In this figure, it can be seen how the different clusters and their respective elements have a smaller distance among them than in the other figures. This may be since collaboration between the different organizations is not still very defined and changes are still needed in the sector.

Finally, it can be stated that there is a connection among the three different sections. In order to be able to see these connections, one last map was created, including all three groups into one, which is represented in Fig. 8 (composed by 17 clusters and 186 items). In this cluster map, it can be perceived that the words technology, regulation and association have the most similarities and links among all the items, since they have the greatest nodes. Therefore, it is possible to conduct the analysis, explained in the next section.

#### 4.2. An analysis of the obtained results

The main objective of this section is to detail the most important aspects of the academic articles previously searched and mentioned. In this way, it will be possible to have a much broader and detailed vision of the technological evolution of this sector taking into account all the information collected. Finally, the results obtained and collected from the tables proposed in this section will be briefly outlined. Keeping in

mind that 193 academic articles were found, it is probable that not all of them will be explained in detail in order to keep focus on the research. Additionally, different subsections are displayed in order to structure the analysis. Table 4 sums-up the research on Challenge, which is divided into four different categories regarding the different topics: Fintech Challenges, Fintech Risks, Digital Banking challenges and Regulatory Challenges. Table 5 details the academic papers related to Regulation, grouped into four subsections: Overall Regulation in Digital Finance, Digital Banking Regulation, Regulatory Sandboxes and Regtech. Table 6 lists the literature review referred to Collaboration.

Having gathered all this information, one of the main conclusions that can be obtained is that, within the financial sector, it is challenging to innovate in a disruptive way, as it is a relatively mature sector. However, the rapid disruption of Fintechs together with their rapid evolution means that this market can potentially collapse, thus entailing a systemic risk.

On the other hand, there is a clear lack of regulation towards these firms, which has both positive and negative factors. The positive effect, from the Fintechs' standpoint, is that they have more "room" to develop their respective businesses, compared to the more traditional financial institutions. However, this can lead to a problem of financial stability, since it is the regulation itself that is responsible of this. Therefore, several mechanisms are being developed (Regtech, regulatory sandboxes...) to ensure the sector is more regulated. Finally, the most important outcome is the importance of collaboration between all the agents in the sector in order to provide a better service to the market. Collaboration between banks and Fintechs is key for the development of new products and services.

#### 4.3. The digital transformation of the banking system

Banking had no choice but to embrace digitalization, completely transforming the way it provides services and interacts with both commercial and corporate customers, due to two main factors: the rapid digitalization within all sectors that compose the economy and the rise of new competitors in the financial sector whose model is based on new technologies.

IBM Institute for Business Value (IBM, 2011) conducted a study about the evolution of the digital transformation process. It highlights that in order to reach a digitalized scenario; companies should propose



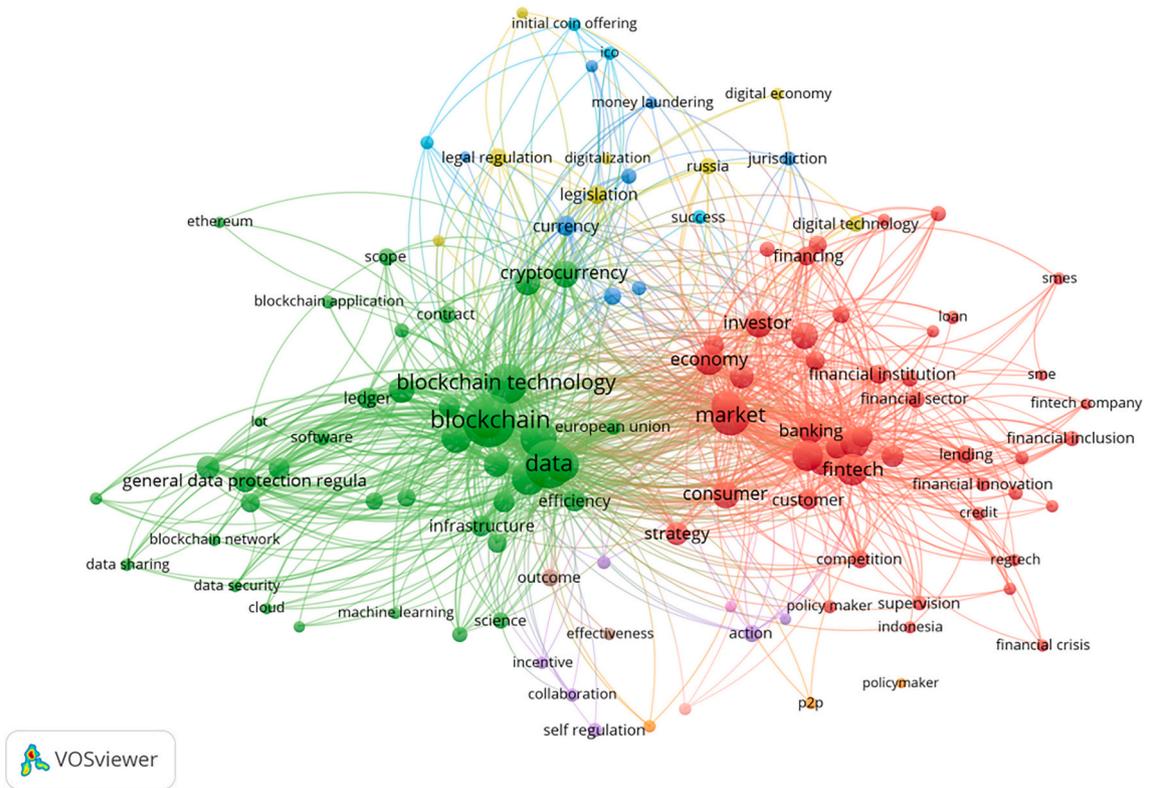


Fig. 6. VOS Viewer keywords from the Regulation category. (121 items in 10 clusters).

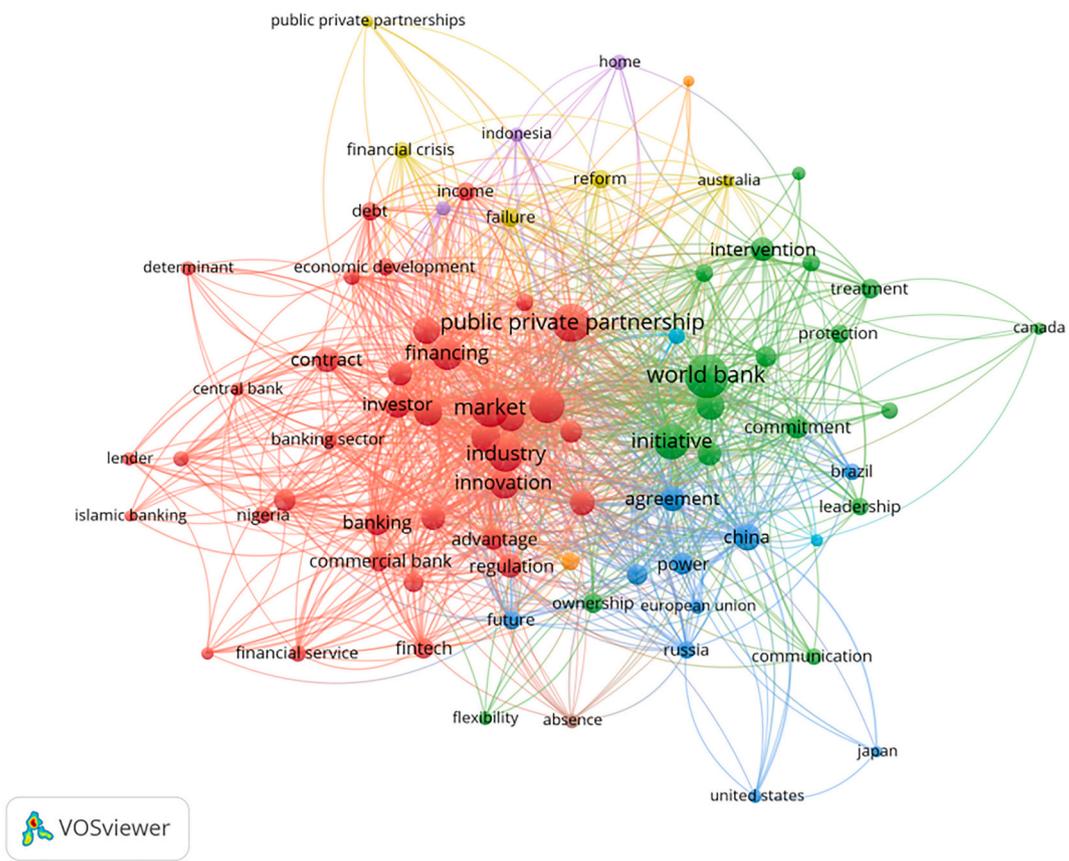


Fig. 7. VOS Viewer keywords from the Collaboration category. (78 items in 8 clusters).

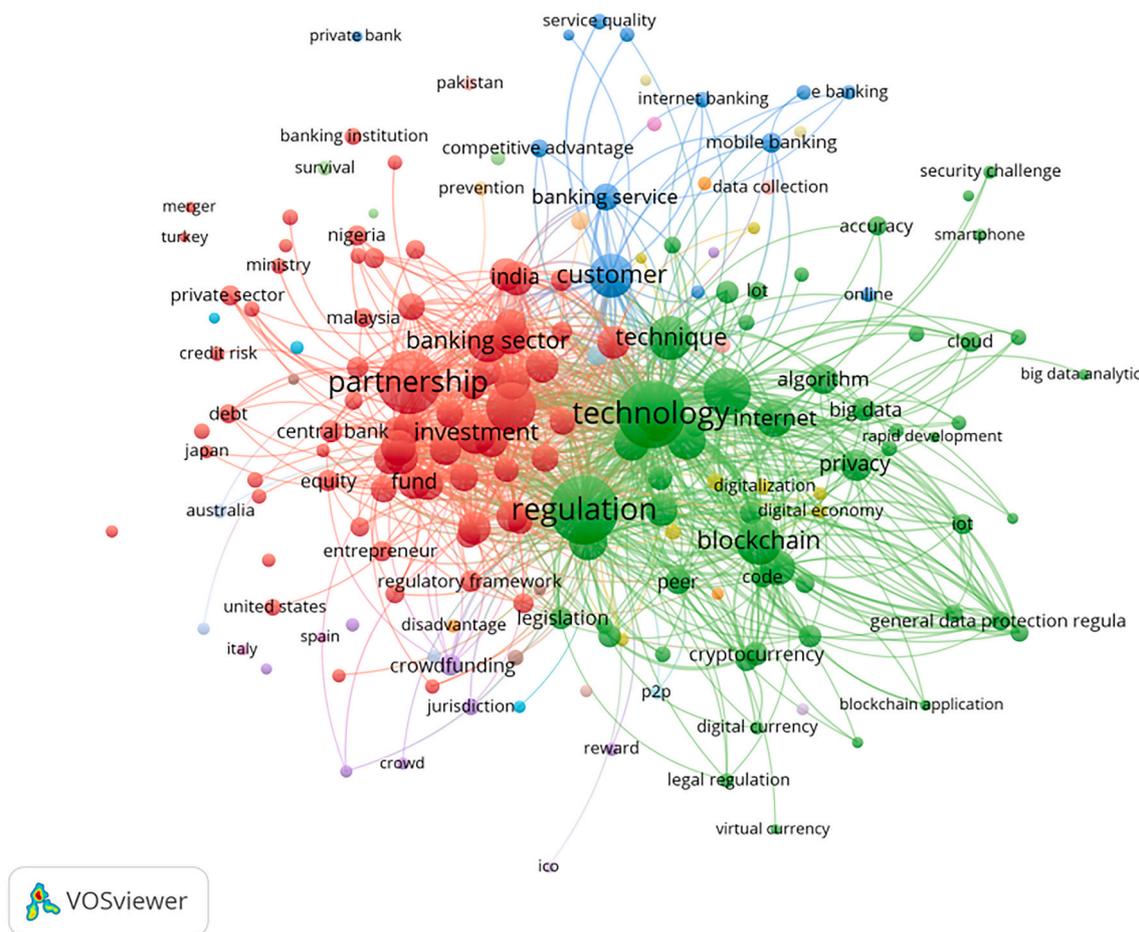


Fig. 8. VOS Viewer keywords set. (186 items in 17 clusters).

### 5. Discussion

Like many other industries, the financial industry has not escaped the impact of digital technology. Although most banks have begun a clear process of digitization, financial institutions are generally moving forward at a slow pace, allowing start-ups and large technological companies to become their competitors. The “attack” by these new competitors is a reality and the threats they pose are increasingly important.

The different services that Fintech companies offer depending on their business model have been studied. In order to develop these new business models, it is necessary to implement techniques and tools that help in the new processes. The use of Big Data technology and ML predictive techniques is a reality for business success. The fact of transforming the huge amount of existing data into useful information allows all the agents in the market to offer new services to their clients more adapted to their real needs.

Even though digitization is a current movement, there are certain limitations when it comes to conducting research, as information in this field varies continuously. This is clearly seen in the systematic literature review carried out in this paper, where the upward trend of publications related to the three chosen topics is also confirmed. From the 193 articles collected in the different databases between 2008 and 2019, this paper performs a co-citation and cluster analysis with respect to the research area and its main keywords. It attempts to identify the key characteristics of research on new players in the financial sector, and aims at help researchers, especially recent entrants, to provide a benchmark for future research. It was revealed that most academic articles belong to the topic of regulation, followed by challenges and

collaboration. However, and as already mentioned, collaboration between the sector’s agents is an essential mechanism to be able to survive in the sector in the long term. Due to the advantages that Fintechs have in terms of regulation (although it may seem it generates an unlevelled playing field), innovation and development of services in the sector is facilitated.

In addition, the last cluster created (Fig. 8) specifically shows the results of the work. The words technology, regulation and partnership show the most similarities and links between all the items, which means that the three topics are currently the ones that the sector is most aware of when developing new services and business models.

Given this scenario, academic research in the area may answer the questions provided in the introduction of the present paper. From a practical point of view, the systematic literature review presented can contribute as a step forward in continuing the intention and guidance of academics regarding the proposed topic. The results can also contribute to the feasibility of technology incorporation and creation of new and innovative banks following the main drivers of Fintech success; development of technology, customer experience, organization culture, funding and government regulations (Hermawan, Septiawan, & Febriani, 2019). In particular, previous studies on the research of services provided by banks and Fintech (Sharif, 2020; Saksonova & Kuzmina-Merlino, 2017) are extended. In addition, studies may complement or even open new research doors, such as that of Dehnert and Schumann (2022), as they concluded that traditional banking attributes, such as human professional expertise, remain important.

Such results help to understand how the industry is evolving in a holistic way, so it would not be entirely correct to focus on the innovations separately by addressing them one by one, as this could lead

**Table 4**  
 Benchmarking the state-of-the art Challenges: an update of research.

Category	Subsection	Description and main ideas	Relevant articles
Challenges	Fintech challenges (35 papers)	<p>Trying to innovate in order to create new services, in a world where everything has already been invented, imposes new challenges. Given the rapid rise of firms, the Fintech sector could assume a systemic risk affecting the economic stability. However, several authors point out the importance of regulation and how it can cope with financial stability (Claessens, Frost, Turner, &amp; Zhu, 2018).</p> <p>Another challenge for Fintech firms is the fact they have to deal with enormous amounts of data using technological solutions, which could develop into a data breach, affecting firm's market value (Unsal &amp; Rayfield, 2019). Processing and data collection raise the problem of suffering attack security restrictions and privacy threat accounts. On the other hand, several authors centered their research on financial stability problems.</p> <p>Research has also investigated the challenges regarding some Digital Finance business functions, specifically, digital lending and virtual currency. One of the main challenges regarding the former is the risk of default (Wonglimpiyarat, 2018). Regarding the latter, the high volatility faced and challenges in security or privacy. This high volatility manifests itself especially in the exchange rates and the prices of these digital currencies.</p> <p>Summarizing the main challenges exposed by authors could be; "investment management, customer management, regulation, technology integration, security and privacy, and risk management" ( Lee &amp; Shin, 2018). The most repeated negative effect among all the perceived challenges is the lack of regulation in the sector, which affects market agents and users.</p> <p>Fintech risks refer to the probability of occurring a non-expected event by firms and its consequences.</p> <p>There are three main types of risks related to the rapid growth of these firms: financial, reputational, cyber risks and data privacy risks (Ozili, 2018). Other authors also point out: operational, management and regulation risks (Aaron, Rivadeneyra, &amp; Sohal, 2017; Carney, 2017). Following the lending industry trend, herding risks are as well mentioned (Da-Silva, 2018). Herding means how the behavior of other agents influences more than the behavior of the market. This conduct may increase the probability of increasing market inefficiencies.</p> <p>The fact of providing financial services online also enhances new types of risks for customers. It is discussed how online banking creates credit risks.</p> <p>It can be observed that, after very rapid growth between 2013 and 2016, the most recent data indicates a slowdown in most major jurisdictions, mainly due to risk management and lack of consumer confidence (Claessens et al., 2018).</p> <p>These challenges are very similar compared with those posed by Fintech firms.</p> <p>The use of digital platforms in traditional banking generates new challenges for firms, like managing the potential network effects they have on users (Jocovski et al., 2020).</p>	<p>Goldfarb, Greenstein, and Tucker (2015), Jagtiani and Lemieux (2017), Comizio (2017), Ryu (2018), Lee and Shin (2018), Kang (2018), Claessens et al. (2018), Carstens (2018), Arner, Zetzsche, Buckley, and Barberis (2019), Rachinger, Rauter, Müller, Vorraber, and Schirgi (2018), Wonglimpiyarat (2018), Stulz (2019), Unsal and Rayfield (2019), Gold and Ali (2019), Golubić (2019), Hamdani, Herlianti, and Amin (2019), Jocovski, Ghezzi, and Arvidsson (2020), Wamba, Kamdjoug, Bawack, &amp; Keogh (2020), Dhote, Pathak, and Kulkarni (2020), Meng, He, and Tian (2021),</p>
	Fintech risks (14 papers)	<p>Security challenges are highly mentioned, where online threats, commonly known as unauthorized access or hacking, are in the spotlight for firms and regulators (Islam, 2014).</p> <p>Interestingly, the growing relevance of digital services allows large technology companies to engage directly with large corporate customers and thus compete with banks in providing financial services to this client base as well.</p> <p>Regardless of the strategy followed, it is of the utmost importance for banks to incorporate innovation to provide new answers to consumer needs and to detect new business opportunities.</p> <p>This challenge comes from those applying the new technologies and not from the technology itself. While the banking industry is highly regulated, Fintech firms, which provide the same or similar services, are not subject to such strict regulations.</p> <p>Regulatory arbitrage is strongly mentioned, although regulators have not addressed a specific approach in order to mitigate it. Regulatory arbitrage promotes Fintech activities since it may be harder to launch new activities in jurisdictions with relatively tight banking license and supervisory regimes (Philippon, 2016). Understanding how the industry develops by balancing both risks and potential innovations helps in developing new regulatory strategies in order to avoid regulatory arbitrage.</p> <p>However, applying traditional regulatory strategies to new high-tech industries may not be the solution. Part of the difficulty is managing the trade-offs that surround the regulation of new developments that could potentially both assist and undermine consumers (Yadav &amp; Brummer, 2019).</p>	<p>Arner et al. (2015), Carney (2017), Aaron et al. (2017), Claessens et al. (2018), Ozili (2018), Da-Silva (2018), Ryu (2018), Milian et al. (2019), Liu, Li, and Wang (2020)</p>
	Digital banking challenges (9 papers)	<p>Regulatory arbitrage is strongly mentioned, although regulators have not addressed a specific approach in order to mitigate it. Regulatory arbitrage promotes Fintech activities since it may be harder to launch new activities in jurisdictions with relatively tight banking license and supervisory regimes (Philippon, 2016). Understanding how the industry develops by balancing both risks and potential innovations helps in developing new regulatory strategies in order to avoid regulatory arbitrage.</p> <p>However, applying traditional regulatory strategies to new high-tech industries may not be the solution. Part of the difficulty is managing the trade-offs that surround the regulation of new developments that could potentially both assist and undermine consumers (Yadav &amp; Brummer, 2019).</p>	<p>Donner and Tellez (2008), Low and Abdul (2013), Islam (2014), Bahl (2016), Jocovski et al. (2020), Boot, Hoffmann, Laeven, &amp; Ratnovski (2021)</p>
	Regulatory challenges (12 papers)		<p>Goldfarb et al. (2015), Philippon (2016), Claessens et al. (2018), Ryu (2018), Yadav and Brummer (2019), D'Silva, Filková, Packer, and Tiwari (2019)</p>

**Table 5**  
 Benchmarking the state-of-the-art Regulation: an update of research.

Category	Subsection	Description and main ideas	Relevant articles
Regulation	Overall regulation in digital finance (91 papers)	<p>Regulation requires that policy makers safeguard consumer protection and financial stability. In reality, financial supervisors have been forced to consider ways of balancing traditional regulatory aims of financial stability and customer protection with the objectives of innovation and growth.</p> <p>Policymakers have not yet concluded how to implement the corresponding policies, since Fintech firms are not considered financial institutions, even though they undertake similar activities. Banks could easily imitate Fintech movements if they were absent of regulation, falling under the regulatory arbitrage approach (Buchak, Matvos, Piskorski, &amp; Seru, 2018). In this sense, shadow banking could be considered a threat, since they exploit the advantages given by regulatory arbitrage because they are “free of regulatory costs” (Navaretti, Calzolari, Mansilla-Fernandez, &amp; Pozzolo, 2018). The majority of articles within this subsection deal with 1) cryptocurrencies, 2) blockchain and 3) crowdlending;</p> <ol style="list-style-type: none"> <li>1. Cryptocurrencies are not regulated as their functions lead to a trust solution, where disintermediation plays a leading role (Keidar &amp; Blemus, 2018).</li> <li>2. Blockchain regulation has been adopted with the aim of influencing the process of change and diffusion of the technology. Some authors claimed the urgent need to implement stricter regulation on this sector, like Guo and Liang (2016). The use of smart contracts is becoming more consolidated, as they increase the security of transactions and reduce the risk of fraud (Kakavand, Kost De Sevres, &amp; Chilton, 2017). Through smart contracts, compliance partnerships can be created between regulators and market participants, thus facilitating near real-time access, analysis and processing of data.</li> <li>3. Regarding crowdlending, it provides countless opportunities for investors and entrepreneurs (Stemler, 2013). Countries such as the United States, Italy, the United Kingdom and France, opted to establish new derogations to ease the equity crowdfunding activities (Gabison, 2014).</li> </ol> <p>Finally, although regulation may be necessary in the financial sector, innovation requires reinventing regulation as it is known by developing new systems and approaches.</p> <p>Although digital banking is rapidly evolving, there is still no common approach to many digital payment services.</p> <p>One of the most cited regulatory frameworks is the Second Payments Services Directive PSD2. (Donnelly, 2016) It was set in 2016 in the EU in order to “integrate further and support a more efficient EU payments market” (Zachariadis &amp; Ozcan, 2017). It tries to promote competition in a market where Fintech firms disrupted the payments services system. However, it would be interesting to discuss the necessity of implementing so much regulation, given that some researches agreed that the less regulation, the higher efficiency boost.</p> <p>Regulatory sandbox is a way of testing firms’ new products and services in a safe and reliable environment, where companies are subject to less exposure from regulators. Among the main activities of sandboxes are regulatory guidance, facilitating testing in international jurisdictions and providing Fintechs with flexibility to compete in financial markets (Alaassar, Mention, &amp; Aas, 2021). They also enable providing better access to funding and encourage developing more innovative products. Regulators require that they incorporate appropriate guarantees.</p> <p>There are two key challenges; reducing the barriers to testing in the current policy environment and ensuring that the risks that arise from testing new products are not transferred to consumers (Bromberg, Godwin, &amp; Ramsay, 2017).</p> <p>Finally, there are a series of conditions to enter a regulatory sandbox, according to Zetzsche et al. (2017); firms need to meet a series of requirements from the regulators. In addition, a scope of individual sandbox coverage is implemented depending on the country, or firm size. Finally, firms also run the risk of being removed from the privilege of not participating in the regulatory sandbox anymore if requirements are no longer met or if risks are too high.</p> <p>As a conclusion, Regulatory sandboxes are a useful framework for firms offering specialized products or services, where existing regulations may be an obstacle to their development. This is why it would be interesting to give more incentives to firms to participate in these.</p>	<p>Stemler (2013), Cumming and Johan (2013), Darke (2013), Gabison (2014), Vismara (2016), Kakavand et al. (2017), Philippon (2016), Groshoff (2016), Guo and Liang (2016), Navaretti et al. (2018), Vives (2017), Buchak et al. (2018), Barberis, Buckley, and Arner (2017), Zetzsche, Buckley, Barberis, and Arner (2017), Ruiz (2017), Hornuf and Schwenbacher (2017), Chockalingam, Dabadghao, and Soetekouw (2018), Anagnostopoulos (2018), Keidar and Blemus (2018), Zetzsche, Buckley, and Arner (2018), Magnuson (2018), Weihuan, Arner, &amp; Buckley (2015), Stulz (2019), Iman (2020), Rodriguez, Scholl, &amp; Pomeschikov (2021)</p>
	Digital banking regulation (9 articles)	<p>One of the most cited regulatory frameworks is the Second Payments Services Directive PSD2. (Donnelly, 2016) It was set in 2016 in the EU in order to “integrate further and support a more efficient EU payments market” (Zachariadis &amp; Ozcan, 2017). It tries to promote competition in a market where Fintech firms disrupted the payments services system. However, it would be interesting to discuss the necessity of implementing so much regulation, given that some researches agreed that the less regulation, the higher efficiency boost.</p> <p>Regulatory sandbox is a way of testing firms’ new products and services in a safe and reliable environment, where companies are subject to less exposure from regulators. Among the main activities of sandboxes are regulatory guidance, facilitating testing in international jurisdictions and providing Fintechs with flexibility to compete in financial markets (Alaassar, Mention, &amp; Aas, 2021). They also enable providing better access to funding and encourage developing more innovative products. Regulators require that they incorporate appropriate guarantees.</p> <p>There are two key challenges; reducing the barriers to testing in the current policy environment and ensuring that the risks that arise from testing new products are not transferred to consumers (Bromberg, Godwin, &amp; Ramsay, 2017).</p> <p>Finally, there are a series of conditions to enter a regulatory sandbox, according to Zetzsche et al. (2017); firms need to meet a series of requirements from the regulators. In addition, a scope of individual sandbox coverage is implemented depending on the country, or firm size. Finally, firms also run the risk of being removed from the privilege of not participating in the regulatory sandbox anymore if requirements are no longer met or if risks are too high.</p> <p>As a conclusion, Regulatory sandboxes are a useful framework for firms offering specialized products or services, where existing regulations may be an obstacle to their development. This is why it would be interesting to give more incentives to firms to participate in these.</p>	<p>Bollen (2010), Liu, Kauffman, and Ma (2015), Donnelly (2016), Zachariadis and Ozcan (2017), Vives (2019), Wolters and Jacobs (2019)</p>
	Regulatory Sandbox (11 papers)	<p>Finally, there are a series of conditions to enter a regulatory sandbox, according to Zetzsche et al. (2017); firms need to meet a series of requirements from the regulators. In addition, a scope of individual sandbox coverage is implemented depending on the country, or firm size. Finally, firms also run the risk of being removed from the privilege of not participating in the regulatory sandbox anymore if requirements are no longer met or if risks are too high.</p> <p>As a conclusion, Regulatory sandboxes are a useful framework for firms offering specialized products or services, where existing regulations may be an obstacle to their development. This is why it would be interesting to give more incentives to firms to participate in these.</p>	<p>Arner, Barberis, and Buckley (2016), Arner, Barberis, &amp; Buckley (2017), Bromberg et al. (2017), Zetzsche et al. (2017), Ingle (2018), Chen (2018), Alaassar et al. (2021)</p>

(continued on next page)

Table 5 (continued)

Category	Subsection	Description and main ideas	Relevant articles
	Regtech (22 papers)	<p>Regtech has appeared as a new regulatory solution in a more effective and efficient approach in order to support compliance and reporting functions (Arner et al., 2016). The possibility of a different financial system is possible thanks to the combination of Fintech and regtech, since the latter not only helps financial institutions to save on costs by complying with their obligations, but also provides the opportunity for regulators to carry out their functions in a considerably more effective manner (Larsen &amp; Gilani, 2017).</p> <p>However, several authors, like Packin (2018), pointed out that regtech is not a panacea. Additionally, many of regtech's gains have been counterbalanced by increased regulatory requirements and their associated costs, such as the growing number of requests for information issued by regulators.</p> <p>Finally, smart regulation is highly mentioned as well; this new form of regulation is necessary to address the new financial system. Smart regulation is the result of the digitization of systems; it involves the definition of new financial infrastructures, including digital identification systems and frameworks for payments and other operations (Zetzsche et al., 2017).</p>	<p>Arner et al. (2016), Zetzsche et al. (2017), Larsen and Gilani (2017), Arne et al. (2017), Anagnostopoulos (2018), Callen-Naviglia and James (2018), Packin (2018)+</p>

to overlooking the big picture of FinTech-induced changes.

## 6. Conclusions

The aim of the new digital banking system is to make the customer the main driver of its operations. The development of new applications capable of improving the user's experience is the key tool they use to gain the trust of these new digital customers. Banking should focus on regaining customer loyalty by offering facilities rather than imposing conditions. Therefore, banks that are unable to adapt could eventually be displaced, and small financial institutions would disappear or would have to merge with large banks in order to survive.

The review of the literature presented allows us to identify the areas that have been investigated and the areas that have not yet been addressed by researchers to date. Gaps have been identified by reviewing the obtained academic papers and their relationship with the clusters; for example, if no papers have been found on a relevant topic such as the use of Robo-advisors in the sector, it is considered as a gap that could be further studied by researchers.

Interestingly, no major research articles were identified with regard to insurance. Undoubtedly, the concept could be considered as fairly novel. However, it is remarkable that research has not addressed this concept more intensively despite the fact that the first platforms in the field were already established over six years ago (Gomber et al., 2017). Robo-advice is another very interesting topic. However, its academic analysis is still pending due to the novelty of such business models and to the Fintechs that are offering this new approach. In this field, research could address several aspects not yet deepened; for example, the different algorithms used or even the analysis of the performance service offered. In addition, no mention is made of the other new players' entrance in the industry, such as challenger banks or neobanks. This could be an innovative approach that could also be a new focus for researchers.

In relation to Digital Money, the focus is mainly on bitcoin as it represents the most important cryptocurrency in existence. Further research on other cryptocurrencies or the interrelation of them could be a potential point of future analysis. However, although most of the individual business functions have already been investigated, the question about what market opportunities can be offered by traditional service providers or by Fintech startups in particular, depending on the corresponding financial function, has not so far been investigated.

Another gap that would have potential for future research is with respect to regulation, which is one of the keywords of the paper. In general, it would be interesting to analyze or measure the impact of

banking regulation on Fintechs and new technologies. Would the market continue to grow in the same way? Would there be as much innovation, or would it stagnate? In addition, it could be inferred that the future of academic research in this area may not focus primarily on the types of regulation as such, but on their underlying technological and innovative rationale. A very promising approach for academic research and for specific Fintech business models is the development of new theories, as well as the implementation of applications and the identification of business models and related services (Gomber et al., 2017).

Within the subcategories identified, it is remarkable that research has not addressed the concept of insurance or Insurtech more intensively. The same is applicable to the crowdfunding types, as most articles deal with equity crowdfunding in greater depth. This is an opportunity for research to examine how the regulation of these functions will evolve depending on the technologies used in their operations. Moreover, numerous articles relate the blockchain technology to ICO (although it has not been developed in this work), which suggests that these technologies and new methods are probably one of the great disruptors when it comes to raising funds. This could be a very attractive research or business theme.

Having exhaustively explored all these articles, potential research for future development can be argued. For example, the existence of regulation on the use of the different technologies used in the sector, more specifically on the different algorithms involved, could be a promising topic. Robo-advisors have also been 'forgotten' in research, and are a potential disruptive technology to financial functions, especially when it comes to investment recommendations to clients. Finally, another interesting topic for future research would be to point out the different paths that countries without regulatory sandboxes are taking, as well as recommendations in these situations could be given by authors.

In general, within the challenges approach, most of them have been investigated. In addition, it could be possible to mention that today one of the biggest challenges for the institutions within the sector are those related to privacy and data security. Therefore, there are numerous regulations to intervene in this problem, such as the GDPR in Europe. However, this issue has not been found in the articles within the regulation category, and therefore it could have more prominence in the future.

It would also be interesting to investigate whether it would be possible in the future for incumbent banks and Fintech companies to carry out M&A transactions instead of collaborating: what the consequences for the financial sector would be?; or, opposite to that, what would happen if either banks or Fintechs disappeared from the market, as the other one would become the 'winner-takes-all' agent? Research

**Table 6**  
Benchmarking the state-of-the-art Collaboration: an update of research.

Category	Description and main ideas	Relevant articles
Collaboration	<p>This category is not divided in different subcategories, since all the academic papers found treat the collaboration and cooperation topic in a holistic way, which leaves a free gap for future investigations.</p> <p>Collaboration between banks and FinTechs, although it does not yet covers a wide range of banking services to a variety of customers, it is becoming increasingly frequent. However, FinTech have not yet been able to penetrate all areas of banking services with the same intensity (Hanafizadeh &amp; Amin, 2022). However, there are situations where banks are adapting Fintech models to their own (e.g. experimenting with blockchain technologies, or expanding their business models into the Fintech lending space). Hanafizadeh and Marjaie (2020) identify 4 banking business models, in which the banking-fintech collaboration fits into the Enabler business model, as it considers them as partners in innovation, IT infrastructure and specific segments. Even so, there are several business areas in which there is cooperation between banks and FinTech; e.g. Sales, Customer Management, Loans or Investment management. All of these trends are clear evidence of the growing collaboration between traditional and alternative sources of finance. Many authors point out the fact that this will be fundamental for the successful development of the sector and are key for the survival in the financial industry (Zalan &amp; Toufaily, 2017). Partnerships are the most popular approach. They are a good form of alliance since they manage to increase the added value of companies and entities. These alliances should be along the supply chain and within the scope of geography, according to several authors. Cooperation and integration are more positive and beneficial to total welfare than to the competitive and substitutive scenario (Acar &amp; Çıtak, 2019).</p> <p>Other types of cooperation are acquisition, joint venture and incubation. The use of innovation hubs to promote innovation by banks and Fintechs is also an operation that is being carried out successfully nowadays (Oshodin, Molla, Karanasios, &amp; Ong, 2017), due to the collaboration carried out by regulators and banks.</p>	<p>Boot (2016), Oshodin et al. (2017), Zalan and Toufaily (2017), Anagnostopoulos (2018), Drasch, Schweizer, and Urbach (2018), Hornuf, Todor, and Milan (2018), Lähteenmäki, Still, and Seppänen (2018), Werth et al. (2019), Acar and Çıtak (2019), Jucevski et al. (2020), Hanafizadeh and Marjaie (2020), Hanafizadeh and Amin (2022).</p>

could contribute to these forthcoming debates.

Finally, the category of collaboration is the least researched and explored by experts in the field, yet it is one of the most promising at a practical level. A potential research would be case studies based on the success of such partnerships. In addition, research could contribute to the study of the differences in cultures between Fintech companies and traditional financial institutions. An analysis of these cultures and their impact on the business models and on business success has the potential to provide very attractive results.

Unlike traditional financial institutions, the use of new technologies allows Fintech firms the possibility of not being so limited in a regulatory sense. This requires that the current regulation would need to be established through international standards, which would imply additional implications and efforts. Even though, banks could potentially benefit from this situation through collaboration. Alliances have been established between Fintech and banks so that both can benefit from the digitization, and strategic alliances have also been created within different banks themselves. For all these reasons, it is interesting to end with the discussion that technological progress will also affect the functioning of companies and incumbents internally, involving not only a reduction in costs, but also new forms of organization, new approaches and objectives. Undoubtedly, this is a change that is presented as a great opportunity if properly taken advantage of.

#### Declaration of Competing Interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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