Fintechs: a global bibliometric analysis and research trends

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Abstract: This article aims to present a bibliometric study of research involving the concept of fintechs from the past 30 years (1991-2020). For this study, the bibliographical data was extracted from Scopus. Among the main results that were found, three stand out. Firstly, this article describes a general panorama of research involving fintechs from the last 30 years in the subareas 'Business, Management and Accounting' and 'Economics, Econometrics and Finance'. Secondly, we detected three generations of research related to this field of study. They are the discovery (1991-2006), the development (2007-2016), and the expansion (2017-2020). Also, we highlighted connections between the three generations, as well as the evolutionary process of the subjects that were addressed in these different generations. The third result was the identification of six themes that represent research trends for the future, which are: 'banking & financial services', 'electronic services & 'e-finance', 'consumer behaviour', 'mobile services', 'risk' and 'cryptocurrency'.

Keywords: Fintechs, Digital finance, Mobile payment, Bibliometrics, Generations, Research trends.

1. Introduction

The fourth industrial revolution has exponentially modified the financial service sector. With the advent of information technology, the financial system started to redefine its routines and processes through technological innovations (Muhuri, Shukla, & Abraham, 2019). Thus, financial operations underwent periodic innovations in their process patterns to fulfill operational gaps presented in the financial system (Breidbach & Tana, 2021; Milian, Spinola, & de Carvalho, 2019; Li et al., 2021).

To fill these gaps, a new economic agent appeared in the financial system, which is denominated as fintech. Fintechs are responsible for automating financial services through technology and, consequently, increasing the financial system's efficiency (Gomber, Koch, & Siering, 2017; Liu, Li, & Wang, 2020). To Fuster et al., (2019) and Chen et al., (2017), financial management and intermediation operations conducted by the fintechs represent an important step for the sustainable development of the economic system, with the potential to reduce financial service delivery costs by up to 90%. Thus, researchers highlight fintechs as the protagonists of a revolution in the payments system (Gomber et al., 2018; Haddad & Hornuf, 2019; Lenka & Barik, 2018).

Due to the advantages afforded by fintechs, this subject has been shown to encompass different sectors (Haddad & Hornuf, 2019). However, despite its relevance, it is still in its embryonic stage and requires more exploration by financial market managers and technology professionals (Thakor, 2020). As a modern research field, this economic agent has awoken multidisciplinary interest, paving the way for analyses pertaining to different fields of research (Milian, Spinola, & de Carvalho 2019; Puschmann, 2017), such as shared economy (Netto & Tello-Gamarra, 2020; Liu, Wu, & Yu, 2019), legislation (Irwin & Dawson, 2017), technology (Chen et al., 2017), finances

(Trivedi, Mehta, & Sharma, 2021; Wang et al., 2020), organizational management (Chen & Bellavitis, 2020) and innovation (Bukhtiarova et al., 2018). As such, many theoretical and empirical analyses need to be developed to better structure information and trends connected to fintechs (Liu, Li, & Wang, 2020; Li et al., 2021). One of the tools used by researchers to increase their understanding of different fields of research is bibliometry.

There is a lack of bibliometric articles in fintechs literature, except for those from Liu et al., (2020), Milian et al., (2019) and Zavolokina et al., (2016). Although these advances are important, a more encompassing bibliometric study is still necessary, especially due to the recent and expressive increase in studies about fintechs. In this sense, this article's objective is to conduct a bibliometric study on the scientific publications about fintechs from the past 30 years (1991-2020).

This study is different from the existing bibliometric studies due three reasons. Firstly, to analyze this phenomenon over a 30-year period permits the identification of aspects that were not identified in shorter studies. This study permits an evolutionary analysis of the fintech phenomenon from a quantitative point of view due to the variation in the amount of studies per time period, and from a qualitative point of view as it identifies the subthemes' evolution during this same time period. Furthermore, this study is not limited to a specific geographical area. Unlike bibliometric studies that analyze research behavior in certain regions, this document analyzes fintech research behavior around the world. Finally, this study identifies three generations of research and how these generations evolve and connect.

Following this introduction, there is a description of the data collection method, and a summary and analysis of the research data. After that, the results obtained in this bibliometric study will be elucidated. Thus, different units of analysis and their variables will be presented. Then, these data will be discussed in order to point out some

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trending directions for future research. To conclude, the last section will address the most relevant insights from the research, limitations of the study and its contributions to the business and academic world.

2. Method

The method used to develop this study is a bibliometric analysis, which has been used in order to obtain a generalized view of a particular field of research. This method aims to quantitatively demonstrate the evolutionary research data and trends in scientific publications for

researchers in the field (Maia et al., 2019). Furthermore, this method makes it possible to evaluate research productivity and research quality by measuring the number of citations and publications (Vanti, 2002).

To produce this document, we used a version of the bibliometric method inspired by Maia et al., (2019) and we adapted it to fulfill this study's objectives. In this sense, we suggest that the method's execution be divided into procedures labeled as: (a) Planning, (b) Search and (c) Data organization and analysis. Figure 1 illustrates the systematic process of this study.

Figure 1. Method summary
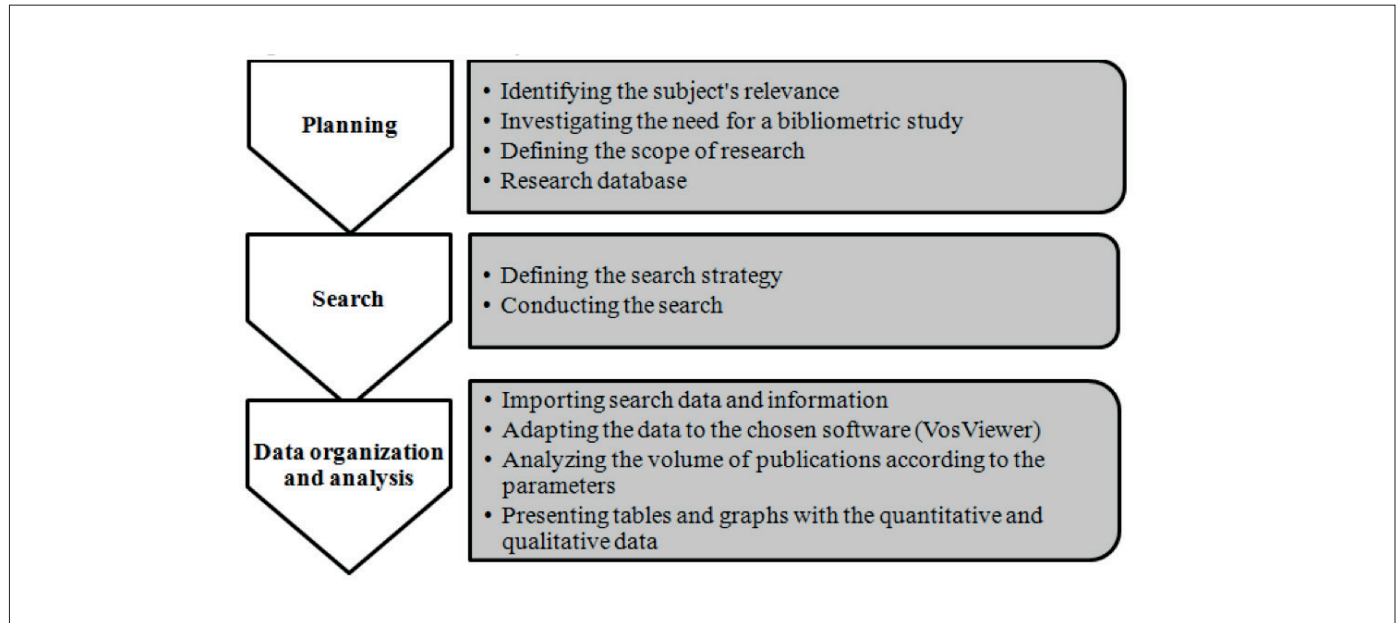
Source: Adapted from Maia et al., (2019)

2.1 Planning

Initially, we intuitively understood that the analysis period would be important for comprehending the fintech phenomenon. To obtain this information, we realized a preliminary search to investigate the relevance of the fintech subject matter in a bibliometric study. This search was conducted on December 20th, 2020, on the Scopus database and included the following terms: "fintech", "mobile payment", "digital finance", "bibliometry", "bibliometric". The search found a total of 14 documents published until 2020. However, most of these studies have two limitations: The first has to do with the age of the articles that were found, as it does not demonstrate the exponential growth of this research field in the past few years. The second limitation has to do with the specificity of the lines of investigation; that is, studies that focus on certain geographical regions or areas. Thus, we proved the lack of more encompassing bibliometric studies pertaining to the fintech subject matter.

To overcome these two limitations, we limited the study's focus to a 30-year period. This time period was chosen as it provides an opportunity to analyze the evolution of this field of study in a broader manner. Finally, we opted to use the Scopus database, due to the

rigor of its analysis process. The Scopus database consists in 'the largest abstract and citations database of peer-reviewed literature, including scientific journals, books, and conference annals' (Scopus, 2020).

2.2 Search

The data collection was conducted in January 2021, focusing on documents from the past 30 years (1991-2020). Considering the use of the term "fintech" and its varying usage, eight more terms were employed: "mobile payment", "digital payment", "e-finance", "e-bank", "cybercurrency", "digital currency", "mobile currency" and "cryptocurrency". The search was conducted with the operator "OR" and an asterisk in the publications' "titles", "keywords" or "abstracts" fields.

When we performed the search for keywords, the terms were written in quotation marks and followed by an asterisk. The quotation marks in Scopus searches make it possible to find approximate terms, giving results for terms with accents and punctuation in the same way as without them (Scopus, 2020). Similarly, the asterisk allows searches for broader results. This character has the function of truncating the suffix of the word, being able to search for radicals of the searched terms.

Furthermore, to refine the analysis, the documents went through three filters. The first one consisted in restricting the search fields. The selected documents had to be a part of the "Business, Management and Accounting" and "Economics, Econometrics and Finance" subareas. The second filter was the documents' language, which had to be English. Finally, the selected documents had to be articles, due to this type of document having strict selection criteria (see Table 1).

Table 1. Search strategy for the bibliometric review

String	Search fields	Filters	Results
"fintech"* OR *"e-finance*"* OR *"mobile* payment*"* OR *"digital* payment*"* OR *"cybercurrency*"* OR *"e-bank*"* OR *"mobile* currency*"* OR *"digital* currency*"* OR *"cryptocurrency*"*	Abstract, Titles and Keywords	Subject area: *Business, Management and Accounting + Economics, Econometrics and Finance* Language: English Document type: Article Years: 1991 to 2020	1920 documents

2.3 Data organization and analysis

In this stage, the data was aligned and imported to the VOS Viewer software, which is used for analyses and for creating bibliometric maps. To conduct the quantitative and qualitative data analyses, we used a bibliographical portfolio of 1920 studies from the past 30 years. The information that was extracted from said studies includes: publication evolution; volume of publications per country; main authors; and the main universities.

Furthermore, indexes were used to analyze the scientific production's evolutionary behavior (Bonilla, Merigó, & Torres-Abad, 2015). These indexes consist of a total number of citations (TC) and publications (TP), the TC/TP index (citations per number of publications) for checking the impact these documents have, as well as the indexes that include the populational factor (in millions of inhabitants) TP/Pop and TC/Pop. As for productivity according to the researchers' origins, we opted to use Google Sheets to present the most productive countries around the world.

Regarding the qualitative aspect, it was possible to detect evolution in this type of research through time. This evolution can be divided into different generations, which differ due to the characteristics of the research developed in this period. To determine in which generations the documents belonged, two criteria were established. The first is the change in the inflection point for publication volume, in such a way that it does not return to its original level. The second criterion consists of the identification of an event that can influence this inflection point. This event can be scientific (an important scientific publication) or contextual (technological innovation, business event, a new law, etc.). Based on these two criteria, we identified three generations: (i) discovery (1991-2006), (ii) development (2007- 2016) and (iii) expansion (2017-2020).

Finally, we conducted an analysis of keyword occurrence and their inter-relation during these generations. We analyzed the most recurrent keywords of each generation and grouped them by subject. To this finality, we used the 100 most common keywords for each generation. For the first generation, we used the entire group of keywords, since the number of keywords in this generation was low. Each main subject was selected for having a recurrency rate higher than 2%. This procedure also clarified new research trends by using the publications from the last 5 years as parameters.

3. Results

This section presents the different topics present in the bibliometric analysis of fintech research. Thus, we present the main results of the global panorama on this subject covering the last 30 years.

3.1 Main countries

To identify the main research centers that work with subjects related to fintechs, we initially analyzed the number of publications per country. Despite this being a boundary subject, the fintech phenomenon and its operations vary in each country. Furthermore, it is possible that analyzes in this area report phenomena that occur in a particular country or that may occur in the future.

By using Google Sheets, it was possible to create a map (Figure 2), which uses color intensity to illustrate the number of publications per country. The countries without any publications in this subject remained white. Of the 193 countries that are currently recognized by the United Nations (UN), 104 of them are present on the map. This shows that 53.38% of the world's countries developed studies on the subject during the time period that was used for the database search.

Figure 2. Countries with publications about fintechs between 1991 and 2020
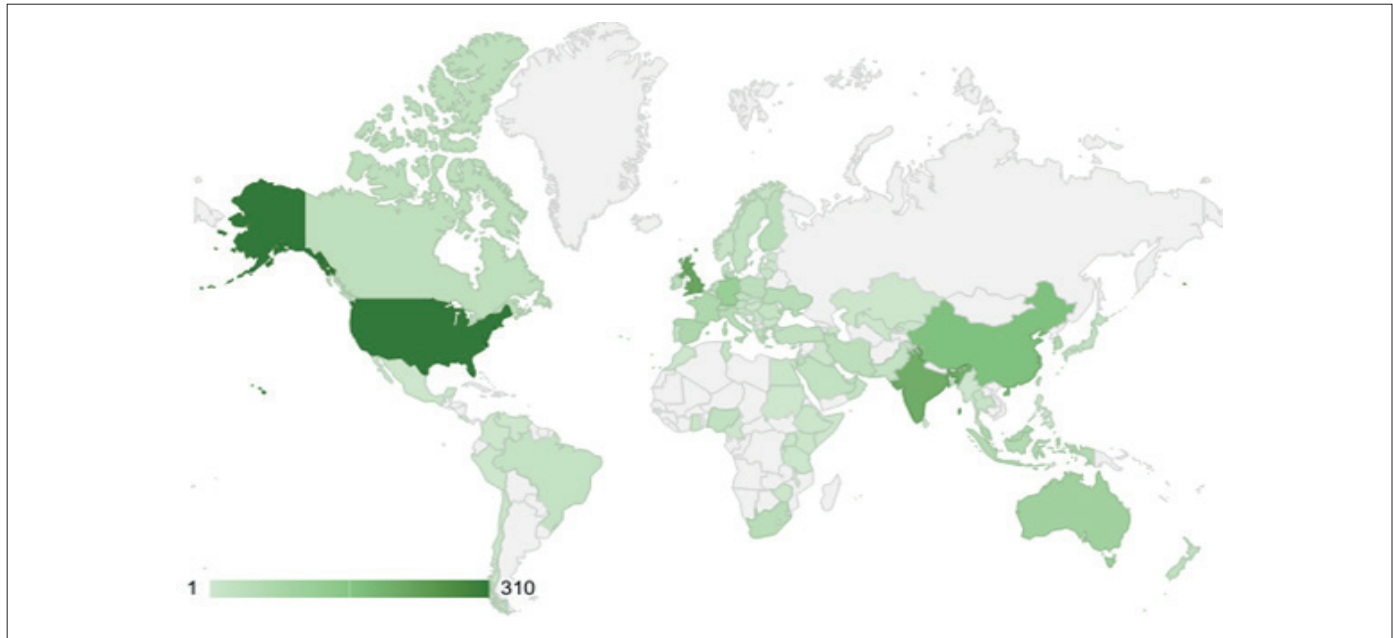
Source: Scopus (2020)

Among the countries with publications, it was possible to highlight that only 54 of these countries possess more than 10 publications, corresponding to approximately 28% of the countries. These numbers show just how new this market agent is and how the analyses pertaining to this subject are still under construction.

In the Scopus database, we identified the ten countries with the highest number of publications on the fintech subject matter and a relationship was established (Table 2) between the number of publications, the number of citations these publications received and the population of the country in question according to data from the UN (2019). In this manner, it is possible to sketch a performance parameter for the studies. The United States are the country with the highest volume of publications in this field, with a total of 310 studies. The United Kingdom is also high up on the list, with 218 publications. Afterwards, there are two emerging powers, India (205) and China (165). When the correlation between citations and publication volume is brought to light (TC/TP), the countries that stood out were Spain and France, with values of 31.29 and 26.84 respectively.

Table 2. Countries with the highest volume of publications

N	Country	TP	TC	TC/TP	Pop (Mi)	TP/Pop	TC/Pop
1	United States	309	7804	25.26	331.00	0.93	23.58
2	United Kingdom	218	4551	20.88	67.89	3.21	67.04
3	India	205	1628	7.94	1380.00	0.15	1.18
4	China	165	2368	14.35	1439.32	0.11	1.65
5	Germany	112	1996	17.82	83.78	1.34	23.82
6	Australia	97	2005	20.67	25.50	3.80	78.63
7	Malaysia	67	787	11.75	32.37	2.07	24.32
8	Spain	66	2065	31.29	46.75	1.41	44.17
9	France	63	1691	26.84	65.27	0.97	25.91
10	Russian Federation	56	250	4.46	145.93	0.38	1.71
11	South Korea	54	482	8.93	51.27	1.05	9.40
12	Indonesia	54	112	2.07	273.52	0.20	0.41
13	Italy	46	444	9.65	60.46	0.76	7.34
14	South Africa	43	335	7.79	59.31	0.73	5.65
15	Ukraine	43	167	3.88	43.73	0.98	3.82
16	Vietnam	42	270	6.43	97.34	0.43	2.77
17	Finland	41	1734	42.29	5.54	7.40	313.00
18	Switzerland	40	864	21.60	8.28	4.83	104.37
19	Taiwan	39	487	12.49	23.82	1.64	20.45
20	Canada	36	458	12.72	37.74	0.95	12.14
21	Poland	36	228	6.33	37.85	0.95	6.02
22	Iran	36	158	4.39	83.99	0.43	1.88
23	Hong Kong	34	1004	29.53	7.50	4.54	133.94
24	Ireland	32	402	12.56	4.94	6.48	81.43
25	Netherlands	31	534	17.23	17.74	1.75	30.10

Within the countries with a higher publication volume, it is possible to notice that there is not always a direct relationship between the total volume of publications (TP) and that of citations (TC). When the TC is analyzed in countries such as India (3rd) and Malaysia (7th), it is evident that although these countries are among those with the highest TP, they do not show the same performance in TC. Furthermore, locations such as Finland (17th) and Hong Kong (23rd) exhibited a high performance in TC, which would place them among the 10 most cited. In this sense, we described the relation between citation volume and publication volume (TC/TP). In this correlation, the countries that stood out were Finland (1st) with a total of 42.29 citations per publication, followed by Spain (2nd) and Hong Kong (3rd) with 31.29 and 29.53 citations per publication respectively.

To mitigate the population size effect, we added the populational factor to the analysis. The relations of publication volume (TP/Pop) and citations (TC/Pop) were measured according to each country's population. Upon doing this, the countries with the highest TP/ Pop were Finland (7.4), followed by Ireland (6.48) and Switzerland (4.83). Thus, the countries that stand out in this case are those with reduced population and an active scientific community. Upon observing countries with a population over 50 million, the United Kingdom (3.21) and Germany (1.34) are the ones that stand out the most. As for the TC/Pop relation, the countries that absolutely stand out are Finland (313.00), Hong Kong (133.94) and Switzerland (104.37). These numbers demonstrate the relevance of publications from these countries, which are in a high position despite their reduced population.

3.2 Most productive institutions
Among the most productive institutions regarding the fintech subject matter (Table 3), the "University of Economics Ho Chi Minh City" stands out. This university alone corresponds to a volume of 28 publications, which is higher than the contribution of 164 countries around the world. Next on the list are "Dublin City University" and "The University of Sydney", both of which have 20 publications.

Table 3. Most productive institutions

N	Affiliation	Country	TP	TC	TC/TP
1	University of Economics Ho Chi Minh City	Vietnam	27	236	8.741
2	The University of Sydney	Australia	19	417	21.947
3	Dublin City University	Ireland	19	322	16.947
4	DCU Business School	Ireland	18	339	18.833
5	Montpellier Business School	France	17	917	53.941
6	Trinity Business School	Ireland	14	277	19.786
7	Universidad de Granada	Spain	13	494	38.000
8	Copenhagen Business School	Denmark	13	203	15.615
9	Financial University under the Government of the Russian Federation	Russia	13	83	6.385
10	Massachusetts Institute of Technology	Un. States	12	1038	86.500
11	Holy Spirit University of Kaslik USEK	Lebanon	12	879	73.250
12	Peking University	China	12	128	10.667
13	Singapore Management University	Singapore	12	344	28.667
14	UNSW Sydney	Australia	12	202	16.833
15	Aalto University	Finland	11	951	86.455
16	Ulster University	Ireland	11	247	22.455

Related to the total citations (TC) per institution, Massachusetts Institute of Technology stands out with 1038 citations, followed by Aalto University (951) and Montpellier Business School (917). The same learning institutions demonstrated that their publications are relevant through the TC/TP correlation, with results of 86.50, 86.45 and 53.94, respectively. To know which institutions publish the most content about fintechs in important. This complements the results pertaining to the main authors, since some of these may possess temporary affiliations.

3.3 Main authors
In the purpose of investigating the authors with more influence on fintechs studies within this research period, their productivity was measured through the number of publications and citations. In Table 4, we can observe the authors with the highest volume of published documents and citations.

Table 4. Main authors

N	Author	TP	TC	TC/TP	*H*-index
1	Corbet S.	19	249	13.11	15
2	Bouri E.	14	819	58.50	31
3	Roubaud D.	12	805	67.08	34
4	Lucey B.	11	220	20.00	37
5	Katsiampa P.	10	492	49.20	9
6	Liébana-Cabanillas F.	10	375	37.50	21
7	Durkin M.	9	203	22.56	20
8	Urquhart A.	8	654	81.75	8
9	Sakkthivel A. M.	8	75	9.38	6
10	Sensoy A.	7	77	11.00	19
11	Yarovaya L.	7	46	6.57	13
12	Wonglimpiyarat J.	7	38	5.43	15
13	Kauffman R. J.	6	458	76.33	46
14	Muñoz-Leiva F.	6	246	41.00	22
15	Plastun A.	6	110	18.33	9
16	Arner D.W.	6	75	12.50	7
17	Wang P.	6	70	11.67	8
18	Zhang W.	6	68	11.33	19
19	Tiwari A. K.	6	64	10.67	29
20	Vo X. V.	6	2	0.33	20

Among the authors with the highest number of publications, only four authors had a publication volume higher than 10 documents. These authors are led by Corbet, who has 19 publications, followed by Bouri (14) and Roubaud (12). Bouri (819) and Roubaud (805) lead the ranking of the most cited authors. Furthermore, it is important to highlight that of the four authors with the highest number of publications, two of them lead the rank of the most cited: in this case, Bouri with 819 citations and Roubaud with 805 citations. In third place on the most-cited list, we have Urquhart, with 654 citations. Urquhart stands out due to the high index of citations per publication (TC/TP), since said author has only published 8 studies, but was cited 654 times and the TC/TP index is 81.75 (the highest correlation between citations and publications).

3.4 Most cited documents

Additionally, Table 5 analyzes the main publications that cover this subject. Upon analyzing the documents, the study "The federal funds rate and the channels of monetary transmission", written by Bernanke and Blinder (1992) deserves special attention. Firstly, this document stands out for being the oldest document included in this analysis. This factor demonstrates that this study was the precursor of a new theoretical analysis line. Secondly, this study deserves to be highlighted for presenting an amount of 1367 citations, which demonstrates the robustness of this analysis and the interest of the academic community in the results obtained.

Table 5. Most cited documents

Document	Author	Source	Year	TC	TC/Year
The federal funds rate and the channels of monetary transmission	Bernanke B. S.	ERA	1992	1367	47.14
What do a million observations on banks say about the transmission of monetary policy?	Kashyap A. K.	ERA	2000	767	36.52
Understanding consumer acceptance of mobile payment services: An empirical analysis	Schierz P. G.	ECRA	2010	487	44.27
Exploring consumer adoption of mobile payments - A qualitative study	Mallat N.	JSIS	2007	422	30.14
Past, present and future of mobile payments research: A literature review	Dahlberg T.	ECRA	2008	389	29.92
Accounting quality and debt contracting	Bharath S. T.	AR	2008	387	29.77
The inefficiency of Bitcoin	Urquhart A.	EL	2016	367	73.40
An empirical examination of continuance intention of mobile payment services	Zhou T.	DSS	2013	357	44.63
Internet-based e-banking and consumer attitudes: An empirical study	Liao Z.	IM	2002	317	16.68
Dynamics between the trust transfer process and intention to use mobile payment services: A cross-environment perspective	Lu Y.	IM	2011	302	30.20
On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier?	Bouri E.	FRL	2017	276	69.00
A proposed model of e-trust for electronic banking	Yousafzai S. Y.	T	2003	265	14.72
Volatility estimation for Bitcoin: A comparison of GARCH models	Katsiampa P.	EL	2017	264	66.00
The economics of BitCoin price formation	Ciaian P.	AE	2016	250	50.00
The adoption of electronic banking technologies by US consumers	Kolodinsky J. M.	IJBM	2004	233	13.71
Modeling Consumers' Adoption Intentions of Remote Mobile Payments in the United Kingdom: Extending UTAUT with Innovativeness, Risk, and Trust	Slade E.L.	PM	2015	227	37.83
The relationship between consumer innovativeness, personal characteristics, and online banking adoption	Lassar W.M.	IJBM	2005	227	14.19
The economics of Bitcoin and similar private digital currencies	Dwyer G. P.	JFS	2015	225	37.50
The economics of mobile payments: Understanding stakeholder issues for an emerging financial technology application	Au Y. A.	ECRA	2008	222	17.08
Bitcoin: Medium of exchange or speculative assets?	Baur D. G.	JIFMIM	2018	210	70.00
The role of satisfaction and website usability in developing customer loyalty and positive word-of-mouth in the e-banking services	Casaló L. V.	IJBM	2008	210	16.15

AMR, *American Economic Review;* ECRA, *Electronic Commerce Research and Applications;* JSIS, *Journal of Strategic Information Systems;* AR, *Accounting Review;* EL, *Economics Letters;* DSS, *Decision Support Systems;* IM, *Information and Management;* FRL, *Finance Research Letters;* T, *Technovation;* AE, *Applied Economics;* IJBM, *International Journal of Bank Marketing;* PM, *Psychology and Marketing;* JFS, *Journal of Financial Stability;* JIFMIM, *Journal of International Financial Markets, Institutions and Money.*

Upon taking into consideration the volume of citations and the temporal distance (TC/Year), other documents were shown as precursors of important research trends. An example of this would be the article "The inefficiency of Bitcoin", by Urquhart (2016), which has 73.40 citations per year, followed by the study "Bitcoin: Medium of exchange or speculative assets?", which was written by Baur et al., (2018) and has 70 citations per year. Both documents cover the same phenomenon which appeared in the financial system. Thus, we notice that the subject "Bitcoin" demonstrated its popularity in this analysis group and is result of this research's evolution.

3.5 Research evolution throughout the years

The research field that includes the fintech subject matter attracts attention from financial market researchers and managers. Studies published on this subject have increased recently, as demonstrated in Figure 3.

Figure 3. Volume of documents published per year (TP/year)
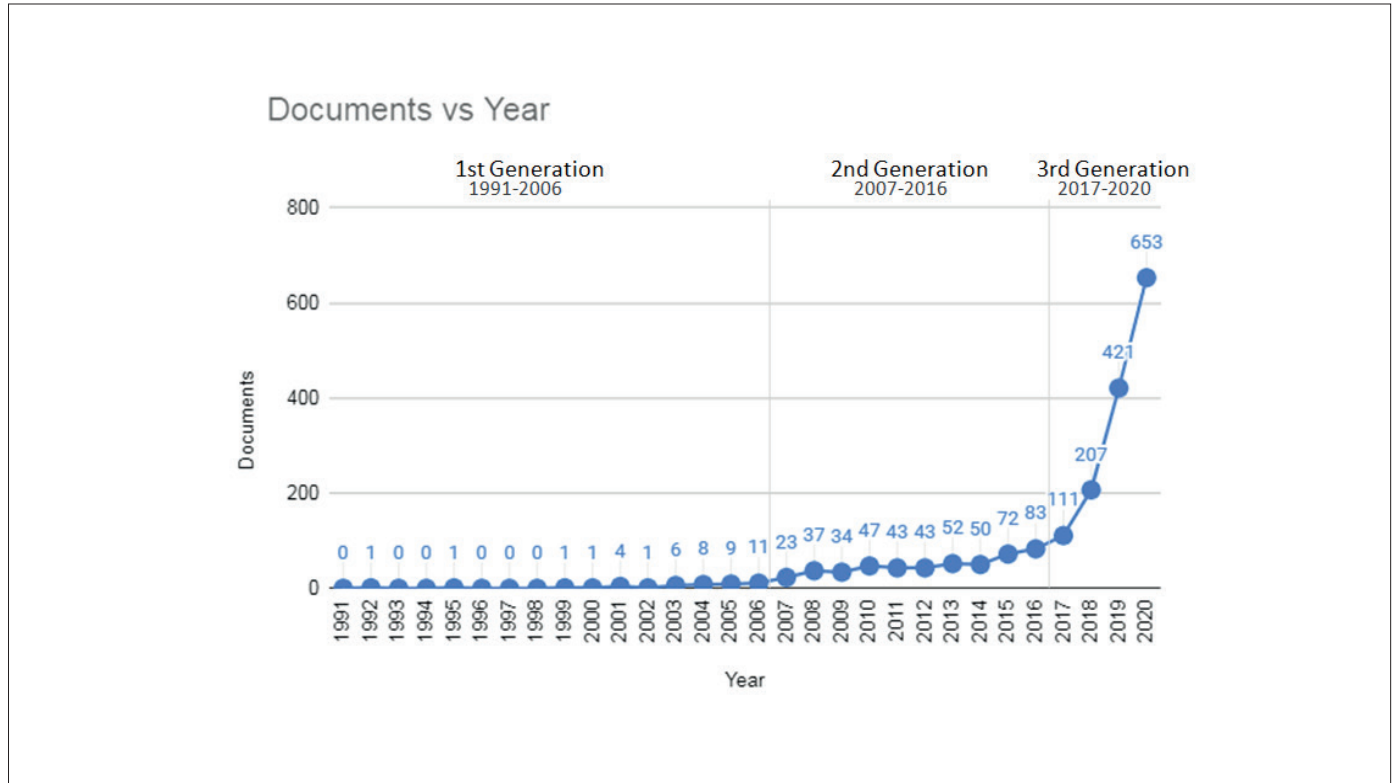
The number of publications per year has its importance justified by demonstrating the relevance that is being assigned to the subject over a certain time period. From the research conducted in this study, it is possible to affirm that the studies that surround the fintechs theme are growing exponentially. These studies began to increase since the year 2007. However, it was only in 2017 that the increase became leveraged and the growth became exponential, reaching around 90% that year. The fintech research trajectory was divided into three generations, which were proposed according to two criteria: one quantitative and another qualitative (see method).

The transition from the first to the second generation happened mostly for two reasons. Firstly, due to the launch of the iPhone and Android operational systems and, simultaneously, due to the 2008 international financial crisis. Furthermore, this transition is also marked by the first publication from the creator of the bitcoin (Nakamoto, 2008). As for the transition between the second and third generations, it occurred due to the maturation of the analyses covering fintechs and their ecosystem (Lee & Shin, 2018; Urquhart, 2016), the regulatory adaptation of these technologies and the inclusion of virtual assistants in financial platforms. A timeline was created to present the research trajectory as well as contextual and scientific events referring to the fintech phenomenon (Figure 4). Afterwards, we present the three generations alongside their main research questions, trends, and keywords.

Figure 4. Fintech development through the generations
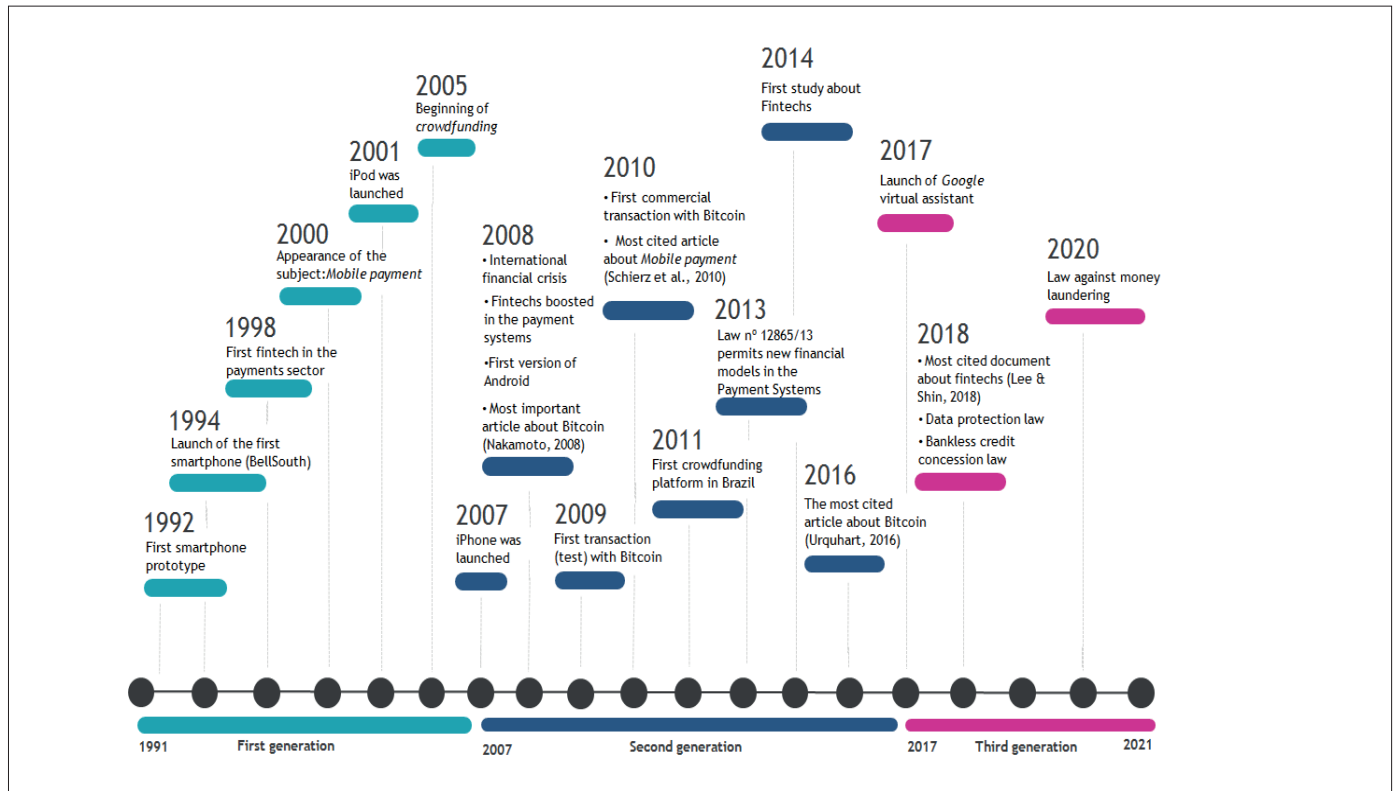
A) First generation (1991 – 2006): the discovery phase

This research generation contains 41 publications. We named it 'discovery phase' as it is the moment when the subject appeared, with a volume of up to two publications per year. In the keyword analysis, it is possible to observe that the 92 terms are all superficial (Figure 5). Although the publications are scarce, there is a slight link between the subjects, which stimulated studies in future generations.

In this generation, it is possible to note that the main subjects that were studied can be divided into: financial services and banking, electronic commerce, electronic banking, which was the predecessor of e-finance resources; and initial studies on consumer behavior.

**Figure 5.** Mapping of keyword co-occurrences (1991-2006)
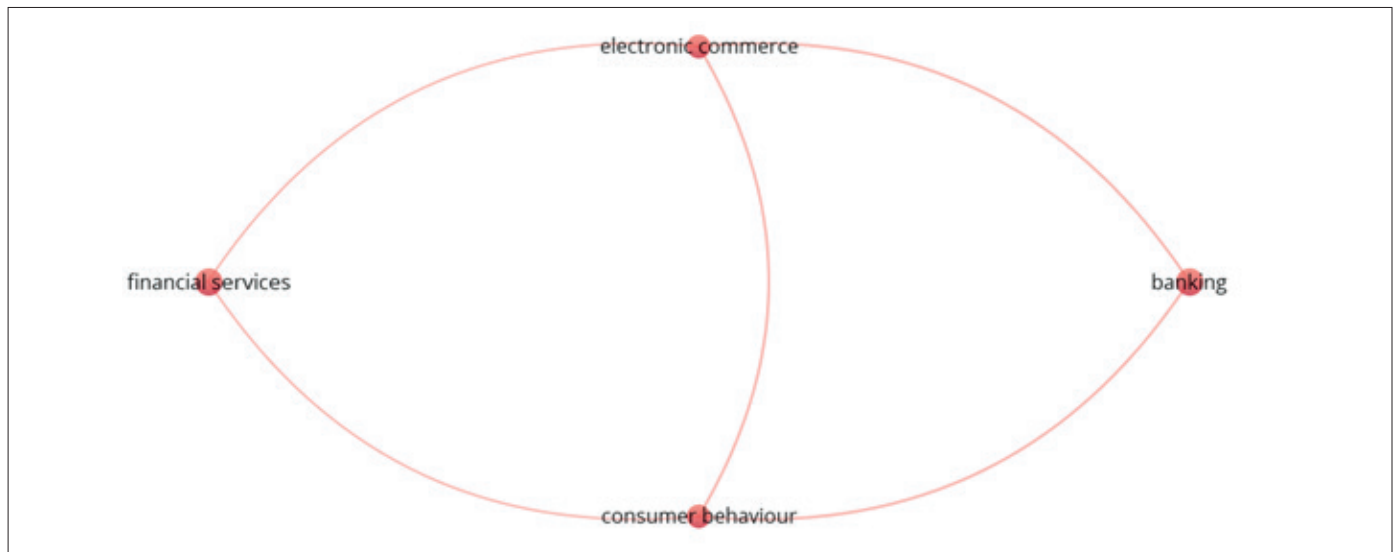
B) Second generation (2007-2016): The development phase

In the development phase, it is possible to visualize a materialization process of technologies in the financial system in the 495 publications from this time period. These studies pay close attention to electronic payments and customer loyalty.

Among the 1652 keywords, two points stand out: the appearance of new word clusters and a stronger link between different subjects (Figure 6). The keywords from the second generation are grouped in five clusters: 'internet banking' (yellow), 'mobile payment' (blue), 'customer satisfaction' (green) and 'digital currency' (purple), with the cluster containing the terms 'e-banking' and 'e-finance' (red) playing a moderating role. This interrelation among the topics shows the subject's development in the scientific community.

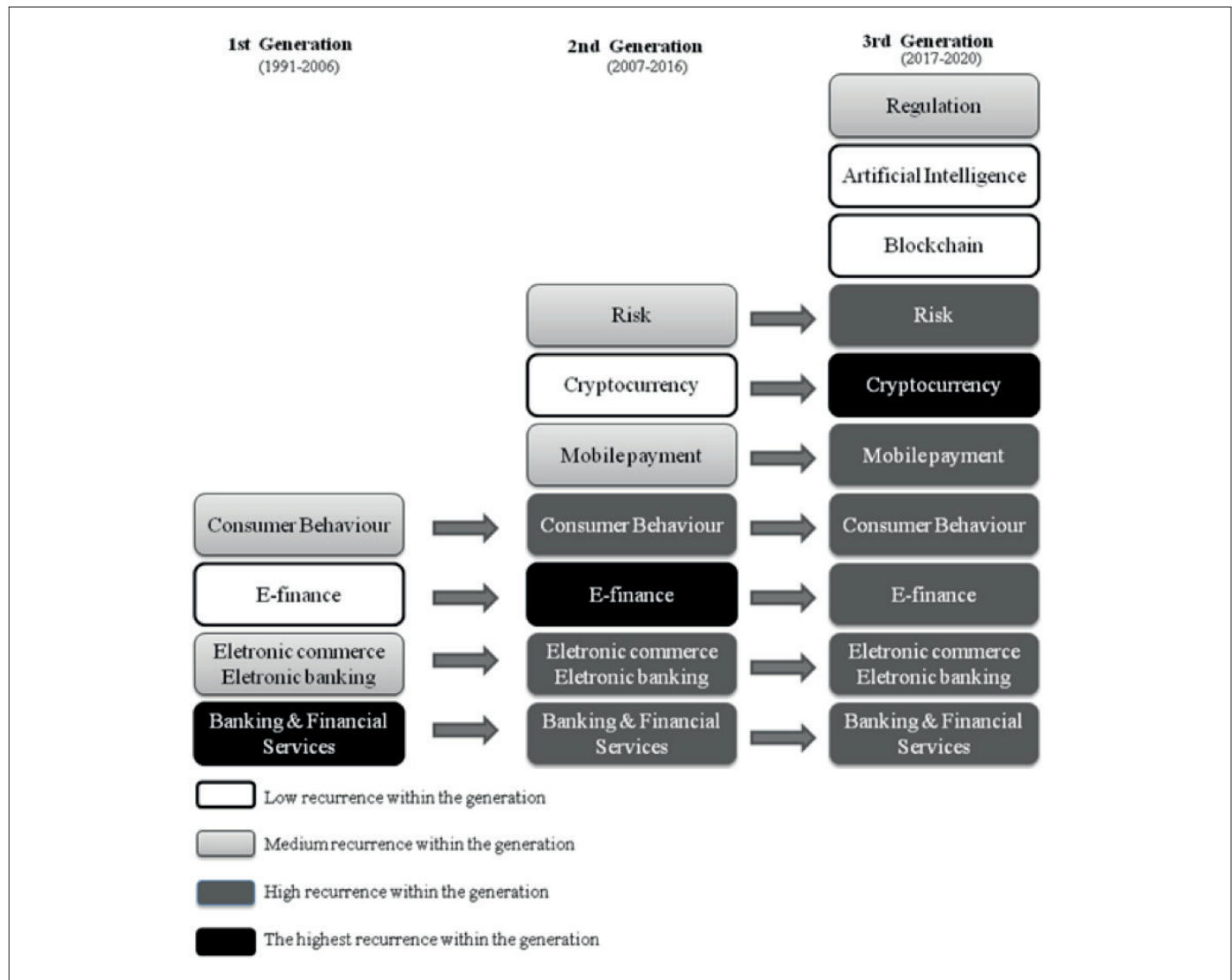**Figure 6.** Mapping of keyword co-occurrences (2007-2016)
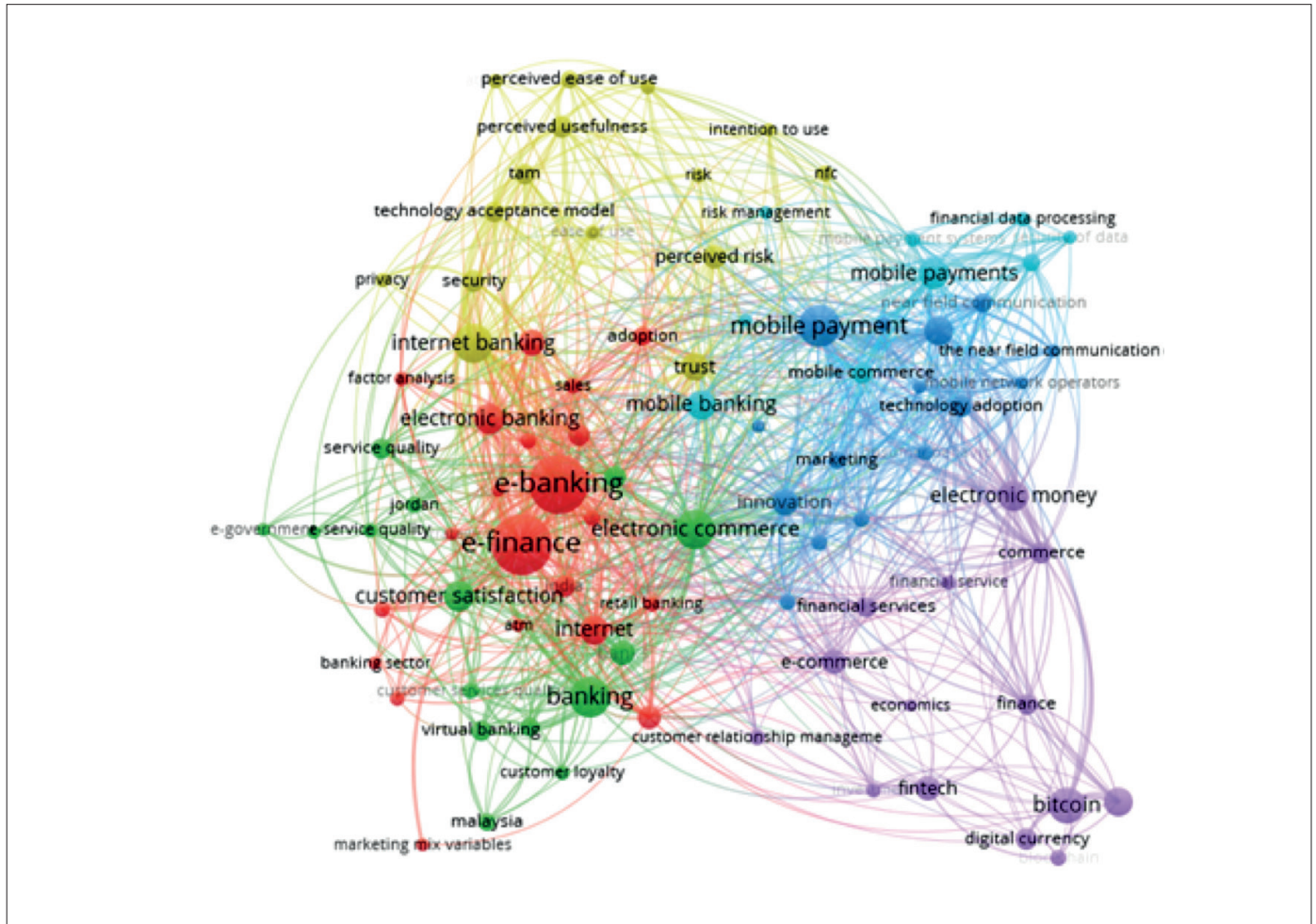
C) Third generation (2017-2020): The expansion phase

This phase is marked by the broadest coverage of the term fintech, with 1475 publications. This generation contains approximately 73% of the publications from the last 30 years. Besides the total increase in publication volume, it is possible to observe the subject's proliferation among researchers of different nationalities.

On analyzing the keywords (Figure 7), it is possible to observe that fintechs take on a multidisciplinary character. Despite the larger spectrum of keywords (3631), this generation demonstrates a stronger link between the terms, which cannot be grouped in independent clusters. This generation shows the strength of terms such as 'cryptocurrency', 'bitcoin' and 'blockchain'. Also, terms like 'monetary policy', 'regtech' and 'regulation' demonstrate the importance of fintechs in regulation. There are also terms that highlight the new trends geared towards financial sector technologies such as 'crowdfunding' and 'artificial intelligence'.

Figure 7. Mapping of keyword co-occurrences (2017-2020).

4. Results discussion

4.1. Connections and evolution of fintechs throughout the generations

In the present study, we analyzed the connection and evolution between the research generations. To fulfill this demand, it is important to emphasize the connecting points that link the three generations. After that, this study will cover the evolution of the identified generations and the main research subjects covered by each one (Figure 8).

In the first generation, we identified that the topics had an embrionary character and none of them specifically reflected what the fintech phenomenon would become. However, said topics were responsible for structuring the comprehension of this phenomenon. The identified themes were 'financial services & banking', 'electronic services', 'e-finance' and 'consumer behaviour'. These four subjects are connected to research from all three generations and were the starting points for different concepts in the following generations.

The second generation is mainly characterized by the appearance of two research topics: 'mobile services' and 'risk'. Thus, the worry about the risk and trustworthiness of mobile financial services is in evidence. In this sense, subjects such as 'mobile payment', 'mobile commerce', 'mobile banking', volatility' and 'trust' stood out in the studies from this generation. Also, the subject 'cryptocurrency' begins to appear. However, the depth of these studies caused the publications with the highest number of citations to appear in this generation.

The third generation is marked by the consolidation of studies geared towards the encryption of financial operations and digital currencies. Among the most-cited topics of this generation, we found: 'cryptocurrency', 'bitcoin' and 'blockchain'. Another characteristic of this generation is the appearance of the term 'fintech', which became popular among the scientific community. Furthermore, new concepts of financial operations appeared, such as 'peer-to-peer lending' and 'crowdfunding', stemming from 'big data' resources and 'artificial intelligence'. The growth of 'regulation' and 'financial inclusion' highlighted the authorities' concern.

Figure 8. Evolution of the topics researched per generation

However, despite the appearance of new research topics throughout the generations, another aspect discussed in this section is the subjects' evolution during the three generations. Quantitatively, the subjects covered in the first generation had a low recurrence rate and were generic. With the generations' evolution, the number and recurrence of the topics began to grow in. This recurrence of the subjects caused them to evolve qualitatively. As for the qualitative evolution, it is possible to note that the subjects gained depth and complexity, generating new subjects with encompassing explanations of different economic phenomena.

The first subject is 'banking & financial services'. This subject is broad and appears in the studies in different ways. In the first generation, the terms 'banking & financial services' appear generically and do not include new concepts. Going on to the second generation, the term covers new topics such as 'internet banking', 'online banking', 'financial services', 'sales' and 'near field communications (NFC)'. Afterwards, in the third generation, this subject is intrinsically incorporated in

the different topics. Besides the changes, this term proved to be the progenitor of the other topics (Wonglimpiyarat, 2017). Due this reason, this is the most cited term in the first generation and maintains its relevance in the following ones.

The second subject covers 'electronic services' in different forms. In the first generation, this topic involves terms such as electronic banking and electronic commerce and has a medium recurrence rate in the first generation. Once studies on fintechs were not yet structured, the concept of 'electronic services' was one of the first steps that the financial sector took. In the second generation, this subject gained a structure and covered the incorporation of virtual and technological resources for financial activities. These new resources were translated by expressions such as 'electronic money' and 'electronic finance'. In the third generation, this term maintained its citation level, but without expanding, since the term 'e-service' took its place (Sardana & Bajpaj, 2020).

The third subject is a concept that is consequence from electronic finance, denominated as 'e-finance'. This subject describe about financial resources created in a digital environment (Tykhonova et al., 2019). Within this perspective, this topic appeared in the first generation in the form of the terms 'e-commerce', 'e-banking', and 'e-finance'. In the second generation, the term 'e-finance' underwent expansion with the addition of topics such as 'e-service' and 'e-governance'. In this sense, this topic was the most cited in the second generation and entered a consolidation stage. In the following generation, it demonstrated its relevance, but did not stand out.

The last subject present in the first generation was 'consumer behavior'. This subject had a generic character in the first generation, being composed of 'market relationship' and 'customer relations' terms. In the second generation, this topic expanded and acquired a multidisciplinary character. In this generation, topics such as 'customer satisfaction', 'perceived usefulness', 'customer services' and 'customer loyalty' came to light. These words clarified the importance of the scientific community developing techniques to retain customers, generate loyalty and satisfaction. (Kaabachi, Mrad, & Petrescu, 2017). In the third generation, this subject was geared towards the relationship between consumers and technology (Lee, Ryu, & Lee, 2019). Thus, terms such as 'technology adoption' and 'technology acceptance' appeared, making this relationship clear in the third generation.

The terms that appeared in the second generation were divided into three subjects: mobile payment, cryptocurrency, and risk. Regarding to the subject mobile payment, it appeared as a protagonist in the second generation. This topic was responsible for bringing up the concepts of mobile banking and mobile commerce. However, all these topics stemmed from the development of smartphones and 'mobile telecommunication', both cited in the studies conducted by Iman (2018). In this sense, expressions such as 'digital transformation' emerged in the third generation. This subject maintained a high citation rate in the third generation and generated a series of expressions.

The subject of cryptocurrency is another one that was conceptually absent from the first generation. The terms that comprise the understanding of cryptocurrency began to appear in the second generation but had a low recurrence rate. With the advent of encryption technologies and the increase in the bitcoin's value, the studies on the matter became more common in the following generation. In the third generation, this recurrence rate increased to its highest point. In this generation, the term 'bitcoin' becomes popular and, in fact, the terms 'cryptocurrency' and 'bitcoin' were the two most cited.

The third subject that stood out due to its not being discussed in the first generation and appearance in the second one was the study of risks in transactions with fintechs. In this sense, topics such as 'risk', 'trust' and 'security' demonstrated the importance of a deeper comprehension related to transactional risks that can be involved due to the presence of these new market agents. This subject gains depth in the third generation since more specific terms appeared connected to this topic. Terms such as 'volatility' and 'smart contracts' came up in this generation. They demonstrate that transactional risk reduction measures have been developed in the digital finances market.

Finally, three subjects were recurrent in the third generation that had not previously stood out. They are 'blockchain', 'artificial intelligence', and 'regulation'. The first subject has grown exponentially, as it is a multidisciplinary tool. Blockchain studies are directly linked to those about the 'internet of things'. Thus, their presence in the financial sector has been crucial for secure digital negotiations. The topic 'artificial intelligence' was found as a part of broad studies, branching off into topics such as 'machine learning' and 'deep learning'. The third subject is part of a regulatory perspective. Besides literal topics such as 'regulation', a new agent, which has been growing exponentially as a resource, known as 'regtech', can help with the operational control of fintechs (Anagnostopoulos, 2018).

In summation, to understand the connections of the three generations and their evolution goes from identifying the subjects with the highest recurrence rate to discovering how they interact throughout the generations. It is important to understand that since it is a subject of exponential and accelerated growth, there is the need for future evaluations to detect newcomers to this market.

4.2. Research trends

To conduct the analysis of research trends about fintechs, we used two bases: (i) the evolution of research themes during the thirty years of studies and (ii) the research themes from the last five years. The first base clarifies that all the third-generation topics will remain active. Throughout the three generations, it is possible to note that none of the studies linked to the fintech phenomenon stopped to be research trends. However, themes from previous generations evolve and mature. Furthermore, the maturation of these studies generates a series of provocations and questions for future generations (see Table 6).

Table 6. Themes, sub-themes, research questions e authors

Themes	Sub-themes	Research Questions	Authors
'banking' & financial services'	'internet banking', 'online banking', 'financial services', 'sales' and 'near Field communications (NFC)', peer-to-peer lending' e 'crowdfunding'	How to guarantee the integrity of peer-to-peer operations in a digitalized financial ecosystem? How healthy are these operations for the financial system? Which new modalities of financial operations will appear, and which will cease to exist?	Lee & Shin, 2018; Chen, 2018; Wonglimpiyarat, 2017; Thakor, 2020; Liébana-Cabanillas et al., 2018; Au et al., 2020
'electronic services' & 'e-finance'	'electronic banking' e 'electronic commerce', 'electronic money', 'e-banking', 'e-service' and 'e-governance'	What is the importance of these new business models in the transactional environment? What is the position taken by formal banks considering these innovations? Which business models would be affected?	Sardana & Bajpai, 2020; Tykhonova et al., 2019; Ayo et al., 2016; Gimpel et al., 2018; Kaabachi et al., 2020;
'consumer behaviour'	'market relationship', 'customer relation', 'customer satisfaction', 'perceived usefulness', 'customer services', 'customer loyalty', 'technology adoption' and 'technology acceptance'	Which opportunities for financial operations have generated the most advantages for consumers? Which modifications happened in the users' digital literacy level? Which gaps can operations conducted with fintechs fill?	Kaabachi et al., 2017; Lee et al., 2019; Ayo et al., 2016; Kotarba, 2016; Szopinski, 2016; Ismail & Osman, 2012
'mobile services'	'mobile payment', 'mobile commerce', 'mobile banking', 'mobile telecommunication' and 'digital transformation'	What are the most effective measures to mitigate risks in these operations? How has the legislation from different countries behaved regarding the adoption of digital payments? Will digital payment methods be formalized?	Matemba & Li, 2018; Iman, 2018; Zhou, 2013; Liébana-Cabanillas et al., 2018; Cao et al., 2018
'risk'	'risk', 'volatility', 'trust', 'security' and 'smart contracts'	Which are the most effective measures to mitigate the risks of these operations/ How has the law behaved in different countries regarding the adoption of digital payments?	Lee et al., 2019; Lenka et al., 2018; Katsiampa, 2017; Wang et al., 2020; Wu et al., 2020
'cryptocurrency'	'cryptocurrency', 'bitcoin' and 'blockchain'	How to guarantee economic stability with cryptocurrency operations? Will companies that work with exchange operations lose space in the market? Will cross-border financial operations lead to a financial democratization?	White et al., 2020; Gomber et al., 2018; Li & Wang, 2017; Chen & Bellavitis, 2020; Mikhaylov, 2020

Although there is a robust scientific cluster related to research on 'financial services & banking', it is still necessary to understand the evolution of the portfolio of banking products. With the appearance of fintechs, it is still unclear which operations can be conducted using the peer-to-peer model (Thakor, 2020). To guarantee the integrity of a digitalized financial system, there is still the need to understand the position of fintechs relative to other financial organizations in terms of service provision.

Regarding to 'e-finance', 'electronic banking' and 'electronic commerce', the provocations can have broad approaches. Concerning this subject, the approaches can be geared towards the new transactional model they have implemented and its adoption (Ayo et al., 2016; Gimpel, Rau, & Röglinger, 2018). Furthermore, the approaches can analyze the affected business models. In this sense, Thakor (2020) points out modifications in credit, payments, investments and insurance. However, the author highlights the need for a more detailed exploration of the subject.

As for consumer behavior, studies have evolved pertaining to client satisfaction strategies and resources for the democratization of financial services (Ayo et al., 2016). Another topic that is trending has to do with the benefits of financial inclusion in countries with different types of institutional gaps (Ozili, 2018; Szopinski, 2016). In this sense,

the intent is to understand the function of digital finances both in developed countries and emerging ones, as well as which operations generate the most advantages for consumers.

Among the subjects that appeared in the second generation, the paths between 'cryptocurrency' and 'mobile payment' cross at various points. However, to understand the risks to the stability of financial systems caused by digital payment methods is a major research trend (Lee, Ryu, & Lee, 2019; Lenka & Barik, 2018). With the appearance of digital payment methods such as the WeChat wallet and WhatsApp pay, the path for evolution in studies on mobile payment is trending (Matemba & Li, 2018; Iman, 2018). It is important to point out that different countries are using similar resources, centralized by the state, such as PIX in Brazil. Besides payment methods, encrypted digital currencies are also objects of study as they permit cross-border transactions (White et al., 2020). It is not a novelty that the future of economic growth is linked to emerging countries and the performance of payment methods in said countries. In this sense, the studies will trace the new profile of the world's payments ecosystem.

Finally, the subjects that appeared in the third generation demonstrated that they are still in development. In this sense, although they present themselves as third-generation research topics, they will

effectively become research trends in the next decade. Thus, the issues of blockchain and artificial intelligence have challenged the scientific community and regulatory authorities. To evaluate the effectiveness and efficiency of blockchain resources still represents a challenge for the scientific community. Furthermore, to understand resources such as networking diagrams, machine learning and deep learning appear to be the field's next research trends. Alongside these trends are the studies that describe the regulatory adaptation of these resources (Anagnostopoulos, 2018).

5. Final considerations

This study aimed to present a bibliometric panorama of fintechs over the last 30 years (1991-2020). This study provides three contributions. Firstly, the description of the trajectory studies on fintechs have taken in the past 30 years. This trajectory shows information that allows the quantitative description of this field of study. This work is unprecedented and allows the reader to have a broad and complete view of the field through tables, analyses, data interpretation and the crossing of relevant data from the field (most-cited documents, authors with the highest publication volume, institutions, countries, etc.).

The second contribution is the identification of three research generations in the fintech field and their connections through time. The field went from primary analyses to deeper investigations on the subject. It was possible to note the generations are connected by the most recurrent subjects. These generations are: discovery (1991-2006), development (2007-2016) and expansion (2017-2020). It is noted that due to the increasing emergence of new terms in this line of research, we hope that this topic can reach a consolidation phase.

The third contribution was the prediction of future research trends about fintechs. Thus, it was possible to identify that the themes from the first generation evolved due to an increase in their depth. The themes from the second generation led to the innovations that society is currently enjoying. The themes from the third generation have demonstrated their worth as subjects for future research throughout the next decade. Also, this field of study will gain other subjects, which will help managers and researchers to deal with new changes in this area.

Besides the aforementioned contributions, this study provides both (i) theoretical and (ii) management implications. Regarding the (i) theoretical implications, this study emphasizes the main areas of study pertaining to fintechs. These subjects require attention from researchers in the technology and innovation field, despite their recurrence, so that the technologies can become a part of the financial system without affecting its stability. Additionally, this study highlighted the evolutionary process of researches related to fintechs. It is possible to identify this evolution individually in the various topics thanks to the evolution of the terms that are used and the appearance of new ones.

As for the (ii) management implications, we suggest that managers advance in the construction of more technological resources, which have the room to expand within the fintech market. Furthermore,

consumer behavior in light of these technological resources must be closely evaluated by the managers of the financial market, since fintechs tend to occupy a majority role in payment systems. The appearance of new customer satisfaction and quality control models represents new resources for institutional innovation in the financial system.

Despite the contributions, it is important to point out some limitations of this study. The main limitation is the use of a single database since some important information may not have been computed. Another limitation consists of the lower probability of newer studies having higher citation numbers, due to their age. This is another factor that reinforces the need for new analyses of this subject later on. We suggest that a literature review be conducted to identify the reasons for the growing interest in this research field within the scientific community.

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