

Fintech Trends and Banking Digitalisation. Insights from a Bibliometric Analysis

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Abstract. *This study presents a bibliometric analysis, the aim of which is to synthesize bibliometric analysis in the fintech field in order to provide a detailed understanding of trends, developments and influence of research and publications in this continuously growing field. Keyword analysis of fintech articles and publications can reveal the main research themes and subfields. By analysing the number of citations and the impact of papers, bibliometric research can help to assess the impact and recognition of researchers and institutions in the fintech community. The sample includes 424 articles, and these results are associated with the term "fintech", with no additional restrictions. The evolution of the number of publications and citations over time is detailed in the analysis below. The term "fintech" started to be significantly more used in Web of Science articles from 2020 onwards. The overall trend is upwards, with 2022 recording the highest number of publications and citations. Therefore, the number of papers is significant and such an analysis gives us the possibility to rank and identify the most cited authors as well as the most prestigious research centres in the field.*

Keywords: fintech, banking sector, bibliometric analysis, VOSviewer, Web of Science

JEL Classification:

1. Introduction

"Fintech" presents a revolution of the entire financial system in the last decades, one of the most progressive changes that has taken over a disruptive behaviour and innovation but at the same time a real threat to traditional financial intermediaries. However, Thakor (2012) attests that fintech is part of the evolutionary process of financial innovation, which has theoretically proven to be risky but valuable, thus Chen et. al (2019) provides evidence arguing that it generates substantive value for investors. In a digital age, fintech applications have redefined today's product-centric thinking to include emerging ecosystems. Individual channels can become redundant when financial services designers focus on hybrid and incompatible modes of interaction-based consumer operations (Gill et al., 2015).

In general, trends in fintech are evolving very quickly and are influenced by changes in technology, consumer demand and regulation. As Frame et. al. (2019) note, technological changes driving financial innovation in banking have implications for fintech developments. Peer-to-peer (P2P) lending without intermediation, cryptocurrencies, and smart contracts are just a few parts of this fintech mix. Financial technology and newer "fintech" topics are gaining additional attention as the effect of digitization on the financial services sector grows (Nicoletti et al., 2017; Leong and Sung, 2018).

The purpose of this paper is to review the existing literature and synthesize bibliometric analysis in the field of fintech to provide a detailed understanding of the trends, developments and influence of research and publications in this growing field. Keyword analysis of fintech articles and publications can reveal the main research

themes and subfields. This is useful for understanding the directions in which fintech research is heading. In addition to identifying key authors and collaborations, the analysis can help to identify authors who have addressed the topic and to understand the degree of collaboration between institutions and researchers in fintech. It is also important to stress that bibliometric analysis should combine the definition of the term "fintech" with a deep understanding of the context and specificities of the fintech field. After defining the term, we will briefly analyse the different aspects of fintech development, leading to the main research questions: How has the number of publications in fintech evolved in recent years? What are the most common keywords used in fintech publications? Who are the key authors or research institutions in fintech publications? We hope these questions will lead to citation and keyword analysis that can help identify specific technologies that are attracting the most interest and assess their evolution over time.

What is Fintech? Fintech, a term derived from the combination of "finance" and "technology", refers to the use of information technology and digital innovations to improve and facilitate the provision of financial services. Currently, the fintech industry is experiencing significant growth, fuelled by innovations in areas such as mobile payments, blockchain, artificial intelligence and data analytics. Thus, the Basel Committee on Banking Supervision (BCBS) assigns the same definition as the Financial Stability Board (FSB) where the term "fintech" is defined as "technology-enabled financial invention that could result in new business models, applications, processes or products with an associated material effect on financial markets and institutions and service delivery".

Since its inception, fintech has been instrumental in financial services innovation in the financial industry. In their paper on the evolution of Fintech, Arner et al. (2015) describe the development of Fintech as an ongoing process "during which finance and technology have evolved together" and which has led to numerous progressive moves.

Currently, we are mentioned to be in the third phase of financial innovation (Figure 1), a first stage is attested in 1866-1967, with the emergence of the first computer systems in the financial sector for transaction and data management.

The second phase, Fintech 2.0, starts from 1967 to 2008, when electrification and globalisation increased, i.e. the use of credit cards and electronic banking increased, and electronic payment systems and global communication networks developed. In the 2000s the Internet boom and the emergence of Fintech begins; the explosion of the Internet brings an increase in online banking platforms and financial services. The beginnings of fintech with the emergence of the first peer-to-peer (P2P) lending and online investment management platforms.

The third phase, starting from 2008 to present, Fintech 3 shows accelerating innovation and accelerated digitisation significant growth in fintech investment, development of blockchain solutions and cryptocurrencies such as Bitcoin, emergence of robo-advisors for investment management, expansion of mobile payment services and digital wallets, including a focus on technological innovations such as artificial intelligence, advanced data analytics and machine learning, increased adoption of blockchain technology in financial services, development of fintech services for SMEs, expansion of technology-based insurance services.

Some experts are of the opinion that more development has not reached its peak, and observers have welcomed the disruption that fintech will bring (Schneider et al., 2016). Thus follows an expansion of the use of financial technology in areas such as personal financial health, financial education and financial services for under-served market segments Fintech covers a portfolio of business activities whose development has become the focus of global companies, the areas that fintech encompasses can be broadly described as: lending services, deposits and capital raising, payment

services, clearing and settlement including digital currencies, investment management services including transaction and insurance.

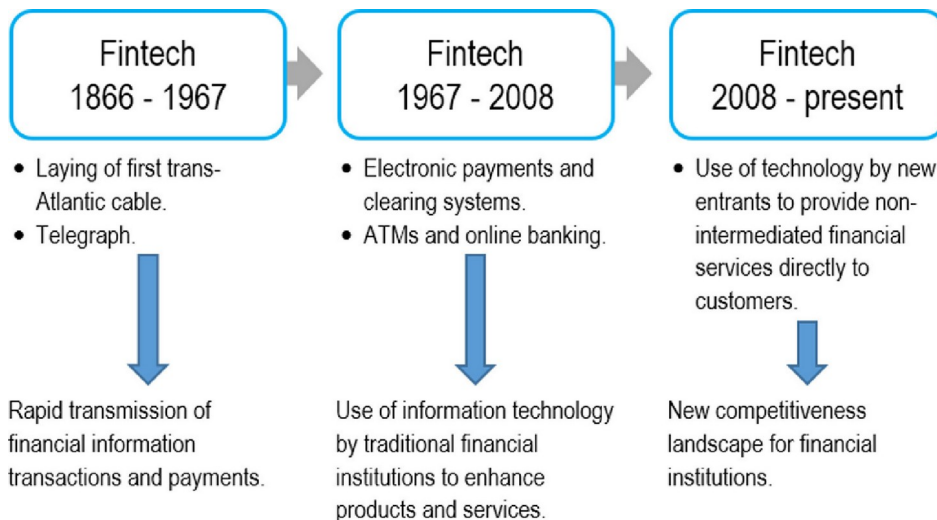


Figure 1. The three phases of fintech.

Source: Thakor, 2019

Another part of the backbone of financial technology is blockchain. Blockchain technology provides solutions for secure transactions and facilitating exchanges of value, independent of intermediaries. On the other hand Hurduzeu et. al (p.614, 2017) states that the processes that are included in the field of Fintech are as follows: techno-credit, techno-placemaking, personal finance, money transfer, blockchain technology, techno-equity, crowdfunding, techno-insurance. Whereas in the paper by Buchak et al. (2018) fintech is considered to include products assisted by bank-provided technologies such as online lending. However some authors exclude banks from the classification but also their definition of fintech. This heterogeneity of definitions and classifications makes it impossible to accurately identify the true size of fintech.

The term "fintech" has its origins in technological developments in the financial sector, and the literature began to reflect this change around 2005-2008. However, it is important to understand that the concepts and ideas behind fintech can also be traced back to earlier periods as technology advanced in the financial industry.

The earliest discussions of technological innovation in the financial sector can be found around the 2000s, with the rise of internet use and associated technologies. However, the term "fintech" itself and the deepening study of this intersection between finance and technology became more evident and better outlined in the literature during the aforementioned years. Over the years, the development of fintech has been influenced by factors such as the rise of digitization, innovations in electronic payments, the emergence of peer-to-peer lending services, blockchain and others. These changes have generated increased interest from researchers, and the literature has evolved accordingly, reflecting these transformations in the financial industry.

2. Materials and methods

Bibliometric analysis takes all types of illumination as a research goal and uses mathematical and statistical methods to study trends and technological development of

science and technology (Moed, 2006; Zhang, 2021). Benchmark measurements have been widely used to reveal the status of research and development trends in a field. They play an essential role for researchers to gain an in-depth understanding of a particular research area (van Oorschot et al., 2018; Vatanan-Thesenvitz et al., 2019). When discussing research findings, a bibliometric analysis is a rigorous methodological assessment with the aim of grouping existing work on the topic and helping to develop evidence-based guidelines for professionals working in the field of study (Kitchenham, 2004; Prinsen et al., 2018). A bibliometric analysis should also identify the state of the art about the research topic (Levy and Ellis, 2006).

Using the specialized software VOSviewer we will do bibliometric analysis. VOSviewer is a computer program for creating maps based on network data and for viewing and exploring these maps. Where, according to the VOSviewer Manual, this program allows the creation of maps based on network data. And maps can be created directly based on the adjacency matrix of a network, but it is also possible to create maps of scientific publications, scientific journals, researchers, research organisations, countries or keywords based on co-authorship, co-occurrence, citation, bibliographic linkage or co-citation networks extracted from Web of Science, Scopus, PubMed or RIS files. These methodologies can also be used to analyse: keywords, authors, institutions, countries, which helps to identify the most frequently used keywords, the most frequently cited authors and research centres. In addition, bibliometric analysis can be used to assess the popularity of the publication among specialists and to check the author's reputation (Ball and Tunger 2005). Also, according to Zupic and Cater (2015), this type of investigation helps to review the literature, leading the researcher to influential research papers or publications, as well as objectively mapping the field of study.

An important advantage of VOSviewer is the visualization that allows detailed examination of the bibliometric maps. This program can display maps in different ways, highlighting various aspects of the bibliometric network. The zoom, scroll and search functionalities facilitate careful exploration of the maps, making it easier to identify significant details. VOSviewer's advanced visualisation capabilities are particularly useful for maps containing at least a moderate number of articles, e.g. at least 100 articles. A significant aspect of VOSviewer is its differentiation from most bibliometric mapping programs, which are described as failing to display such maps in a satisfactory way. Such methodologies are beneficial for illustrating the bibliometric and intellectual structure of a field study when combined with network analysis (Baker et al. 2020; Tunger and Eulerich 2018).

As part of this research, we conducted a comprehensive analysis of author keyword co-occurrence, with a particular focus on keywords appearing below the abstract, setting a minimum threshold of 50 papers in which these keywords are present. We also examined co-citation, with a minimum threshold of 25 articles receiving citations from the same paper. In addition, we investigated co-authorship from the perspective of institutions and countries, where we considered the number of co-authors among the most effective sources, setting a minimum threshold of 25 papers. Using these criteria, we constructed maps and analyses using the VOSviewer tool, highlighting connections between articles, researchers, institutions and keywords. The links were assessed according to their strength, expressed as positive or negative values, to provide a detailed picture of networks and relationships within the field of study. This comprehensive and detailed approach to bibliometric analysis allowed for a comprehensive understanding of scientific networks, collaborations and research themes within the field under review. The size of an article's node in the analysis map indicates its weight and significance in the overall sample. A larger node suggests a more significant contribution of the article to the overall bibliometric analysis. Items are

grouped to form clusters, but it is important to emphasise that these clusters do not necessarily cover all items in the generated map. Therefore, there may be items that do not fit into any of the clusters. In interpreting the results, attention is paid to the links and the attribute total link strength. This attribute illustrates the number of links between items and their intensity in the bibliometric analysis. In interpreting the results, attention is paid to the linkages and the total linkage strength attribute. This attribute illustrates both the number of links between articles and the strength of these links in the bibliometric analysis.

Using a similar tool in bibliometric analysis, it is possible to perform hierarchies related to the authors with the most citations, the research centres that generated the most publications in the field of interest, and the most frequently used keywords.

3. Results

In order to gain a deeper understanding of the origins of the term "fintech", its evolution over time and the fields it encompasses, we conducted a detailed bibliometric analysis. This approach involved examining relevant online Web of Science bibliographic resources, scholarly articles, publications, and other sources of information to identify significant trends, connections, and developments in the use and development of the term "fintech." In order to perform a relevant analysis, publications in the field of fintech were selected, resulting in a sample of 424 articles. These results are associated with the term "fintech", without imposing any additional restrictions. The evolution of the number of publications and citations over time is detailed in the analysis below. The term "fintech" started to be significantly more used in Web of Science articles from 2020 onwards. The trend is upwards, with 2022 recording the highest number of publications and citations.

3.1. *Fintech-related publications author keyword co-occurrence network*

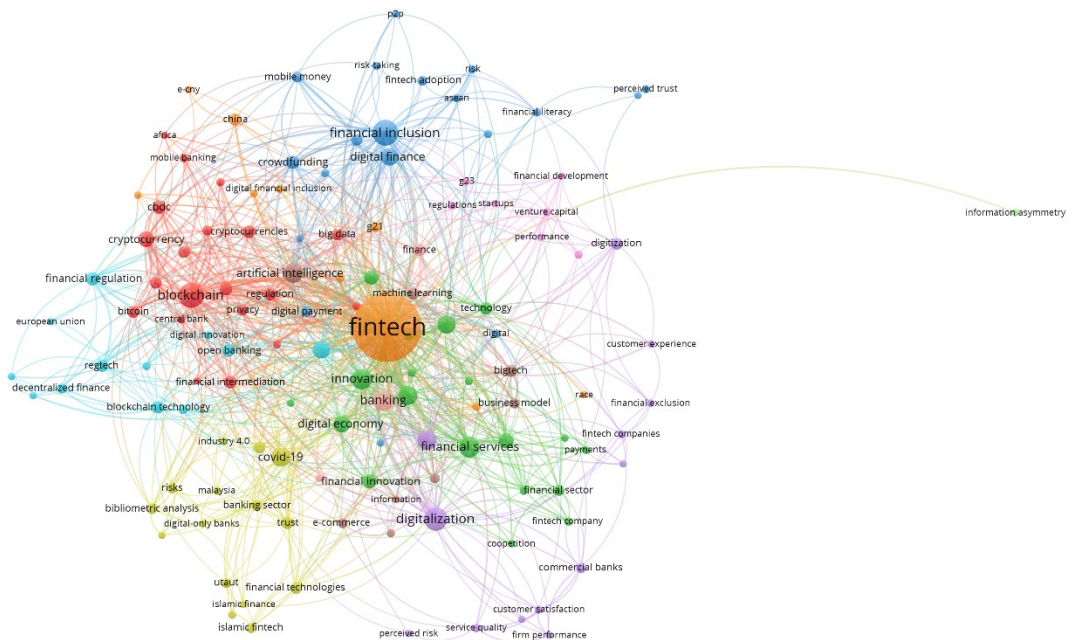
This analysis aims to highlight the most persistent keywords by understanding their simultaneous occurrence in the same article. It is important to stress that the keywords considered in this analysis are exclusively those mentioned by the authors in the abstract part of the articles. By means of this graphical representation, we are able to deduce which keywords are most frequently used by authors in the field of financial technology. The method used also allows us to identify not only the frequency of keywords used by the author, but also the relationships between these words.

In Figure 2, the words most frequently used by authors in the domain of interest are shown, together with the relationships between them. The size of a node represents the importance or frequency of the keyword, and the distance between nodes indicates the strength of the relationship between them. Also, the relevance of co-occurrence of keywords is illustrated by the thickness of the lines, the thicker the more frequent the co-occurrence.

Sets of related words or groups of words are highlighted with the same colour, resulting in the formation of six distinct clusters: cluster one (orange), cluster two (red), cluster three (blue), cluster four (lime green), cluster five (purple) and the sixth cluster (green). A minimum keyword co-occurrence threshold of 25 was applied in the database analysis, which included 424 articles. This means that a keyword must occur in at least 25 articles to be considered relevant. The total number of keywords used by authors identified was 1198, and those that met the above condition were 127.

The first cluster (orange) is led by "Fintech" with 233 occurrences and 554 strong links in total and contains the highest number of keywords such as: digitalization, artificial intelligence, blockchains, banking and others.

Cluster two (red) led by the word blockchains with 31 simultaneous occurrences and 110 strong links. The cluster ranking is followed by cryptocurrencies and Central Bank Digital Currency (CBDC). The links between nodes in this cluster are the shortest



VOSviewer

compared to the other clusters, indicating a strong relationship between these keywords.

Figure 2. Co-author network of authors' keywords on fintech
Source: own processing in VOSviewer

Cluster three (blue) is represented by the analysed keyword "financial inclusion", which is also the largest node, i.e. has the highest weight. This word has 32 occurrences and 95 strong links to other keywords. This cluster has the thickest lines between nodes, indicating a more frequent co-occurrence compared to the others. This cluster also contains the keywords "digital finance" and "mobile money" which have significant nodes: 46 and 17 occurrences respectively.

The last cluster contains the smallest number of items but is represented by one of the keywords of this analysis, namely "innovation", which has 20 occurrences and 77 strong links. The other keywords included in this cluster are banking digitisation, financial technologies, financial services and others. These nodes are in the farthest part of the cluster, indicating a weaker relationship between them.

3.2. The Fintech author co-citation network

In this case, considering the smaller number of authors, the threshold is lower for the number of citations of an author so that the authors with the most citations can be included in the analysis. Thus, Figure 3 represents 4 clusters with 1140 authors of which 760 meet the thresholds. The authors are grouped into 4 clusters as follows:

cluster one (blue), cluster two (red), cluster three (green) and cluster 4 (lime green). The first cluster (blue) consists of 3 authors, the author with the most papers (6) and citations (84) but also the highest total link strength (14) in this cluster is Arner Douglas W.

Douglas (2016) notes that "Financial Technology" or "FinTech" refers to the use of technology to provide financial solutions. The origin of the term can be traced back to the early 1990s and refers to the "Financial Services Technology Consortium", a project initiated by Citigroup to facilitate technology cooperation efforts.

The second cluster (red) represented by 2 main nodes, namely the authors: Buckley Ross P. and Zetsche Dirk A. The authors have a number of 5 documents, with the most citations of 95 and including 14 strong links. Where Buckley et al. (2016) state that FinTech technology is the tool that weaves together a series of processes into one coherent customer journey by organizing customer service interactions on a digital platform.

Cluster three (green) is represented by 4 smaller nodes, this fact indicates that the number of citations is lower compared to the previous nodes, the main authors are: Weber Rolf H., Zetsche Dirk A., Arner Douglas W., and Buckley Ross. Small distances within a cluster three may indicate that this suggests that those elements are mentioned together in articles or that there is a frequent co-occurrence of them in the literature. In general, a small distance indicates a closer association or relationship between the respective elements. Thus Weber, Zetsche, Douglas, and Buckley (2019) state that: at the same time, the rapid evolution of fintech generates new risks. The large amount of data makes it easier to examine correlations rather than causations, and correlations can lead to unintended and socially regressive consequences. However, methods for proper supervision and control of self-learning algorithms have not yet been developed.

The fact that the last cluster (lime green) contains only 2 authors: Castellano Giuliano G. and Tosato Andrea suggests that these authors have a close association or collaboration regarding the analysed publications. This tight cluster indicates that these authors contributed to the same financial technology topic and worked together to a significant extent.

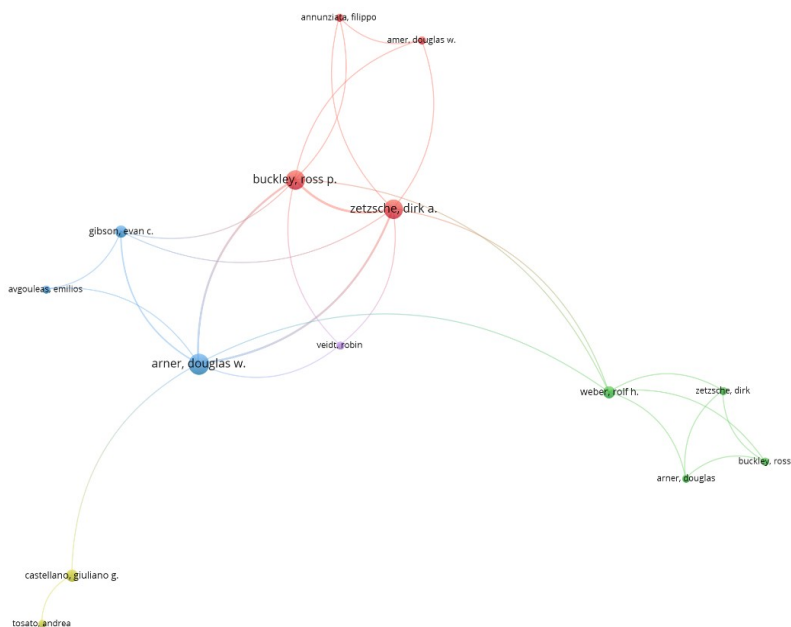


Figure 3. Author co-citation network on Fintech

Source: own processing in VOSviewer

3.3. Co-authored Institutional Review on Fintech

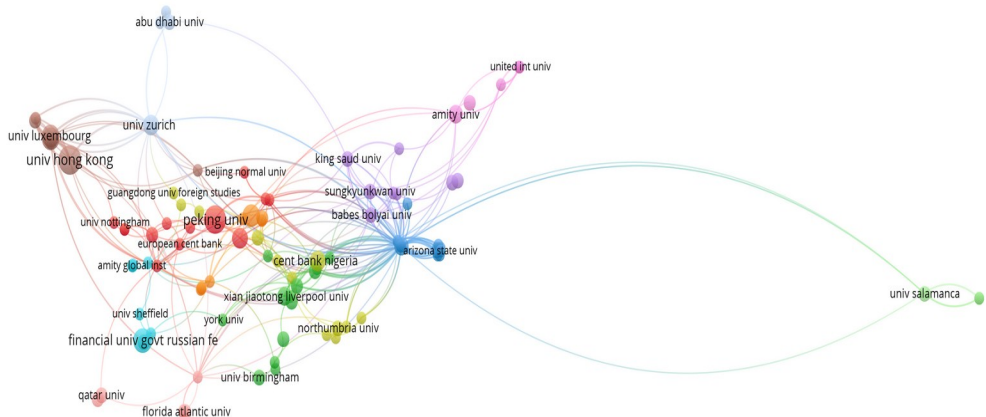
Within this analysis, according to figure 4, the institutions of significant importance in terms of the volume of published documents and research carried out in the field of fintech are noted. From the total of 745 institutions taken into account, by applying a threshold of at least 25 published works (with the aim of highlighting the top institutions that contribute significantly to fintech research), we obtained a ranking consisting of 12 clusters. This forward-thinking approach allows us to identify and highlight leading institutions that are making a significant contribution to scientific output in this ever-growing field.

Cluster 1 (red) and cluster 8 (brown) show the largest nodes, in the case of the network based on research institutions, a large node represents an institution with a significant contribution to the field.

Cluster 1 (red) is represented at the top of the ranking by Peking University, which has a significant number of 9 fintech papers, including 59 citations, indicating that it is a significant contributor to research in the specific fintech subfield. It has 7 links with the following institutions: Poznan Univ. Econ. And Business, Bucharest Univ. Econ. Studies, Baking Univ., CEPR, European Cent. Bank, Mahidol Univ., Punjab Univ.

Cluster 8 (brown) is represented by the Univ. Hong Kong, which has the most publications, 10 articles, but does not have the most citations, has 115 citations and 24 strong links.

At the top of the ranking with the most citations (451) and the most links (32), but with a small number of publications (2) is Univ. Minnesota represented by the blue cluster. The most cited institution represents a number of papers that are extensively cited and have a strong influence on subsequent research.



Egypt and Lebanon. In this cluster, England stands out as the leader with the highest number of citations, totaling 1217, and the highest network connection, totaling 226 links. This indicates a significant contribution of England to the research field under review, both through extensive recognition through citations and through strong connections with other research entities. These results can highlight the significant influence and relevance of researchers and institutions in England in the context of international collaborations and contributions to the advancement of the field. Subsequently, Germany ranks second in the orange cluster, standing out with 31 articles published in the analysed research field. Germany also stands out with 989 citations, reflecting the recognition and substantial relevance of their research in the scientific community. With 218 links, Germany maintains significant connections with other research entities within the cluster. These data underline Germany's considerable contribution to the progress and development of the field, both through active article production and extensive collaborative networks. Together with England, Germany forms a solid core in this cluster, suggesting increased potential for fintech and innovation generated through cooperation between these two countries.

The green cluster includes the following countries: Russia, Spain, Japan, Ghana, Sweden, Estonia, Spain, Portugal and New Zealand. The largest node in the green cluster is associated with Russia, presenting 39 articles published in the field of fintech. With 65 citations, the recognition and positive impact of Russian research works in the scientific community is highlighted, suggesting their significant influence. also, Russia maintains 31 links, indicating an extensive collaborative network with other research entities within the green cluster. This significant connection may suggest the active exchange of ideas and collaboration between Russian researchers and those from other countries in this cluster. Thus, Russia plays an important role in the dynamics of the green cluster, contributing to the diversity and depth of research in this field.

The lilac cluster is composed of two distinct countries: the United States of America (USA) and the Czech Republic. The United States, as the main contributor to this cluster, stands out through the presence of 49 documents published in the analysed research field. With 927 citations, USA makes a significant contribution to the recognition and impact of their research in the scientific community. With 140 links, the USA also demonstrates a strong presence in the collaborative network, indicating strong connections with other research entities. On the other hand, the Czech Republic contributes to the cluster with only one link and only 4 published articles, accompanied by 5 citations.

4. Conclusions

The fintech study makes a number of contributions, managing to cover specific gaps in the specialized literature. By applying a detailed bibliometric analysis, it offers a unique perspective on the evolution and trends in this sector. This methodology, not used extensively so far in the fintech field, allows not only a deeper understanding of the dynamics of publications and research, but also highlights the growing interest in this field, especially starting in 2020.

Furthermore, the study contributes to the detailed mapping of fintech research, identifying major themes and sub-areas of interest. Thus, through its approach, the study not only adds a new dimension to fintech research, but also responds to a clear need to synthesize and comprehensively analyze the existing literature. Thus, his contributions are significant, marking an advance in the way we understand and relate to the evolution and impact of fintech research.

The presented study, on the other hand, has relevant practical implications. By

identifying authors and institutions with a significant impact in the fintech community, the research contributes to the recognition and evaluation of their contribution to the field. At the same time, the obtained results can guide the decisions of practitioners and researchers, directing them to the most relevant and innovative areas. In addition, the extracted information can serve as a foundation for the development of investment policies and strategies in this sector.

Therefore, the study not only enhances the theoretical understanding of the fintech field, but also plays a significant role in the formation of practical and strategic directions. Thus, his contribution transcends academic boundaries, directly influencing the evolution and dynamics of the fintech sector.

The conclusion of the bibliometric analysis on fintech trends, carried out on a set of 424 articles selected from the Web of Science database in the period 2020-2022, reveals a significant interest from researchers in this topic. Fintech trends have attracted the attention of a significant number of researchers, suggesting that this area is the subject of increased interest in the academic community. The keyword map provides essential insight and suggests that Fintech research is characterized by a complex web of interconnected concepts, with a focus on digitization, artificial intelligence, blockchain and banking.

Through author co-citation analysis, maintaining a minimum threshold of 25 co-occurrences, we identified the authors with the greatest influence in the research field, represented by the largest nodes in the graph. This method, as pointed out by Ball and Tunger in 2005, allows us to assess the reputation of authors. Thus, considering most citations, the authors with the highest reputation are Buckley Ross P., Zetzsche Dirk A., and Douglas Arner. Therefore, these authors make significant contributions and are considered benchmarks in the analysis debate.

Through the co-author analysis of the countries in the field of interest, having a minimum threshold of 25 published documents to be considered relevant, we identified 57 countries out of a total of 78 that meet this criterion. Among the top 5 countries with the most significant research activity are China, USA, Russia and England. Institutions/universities that stand out for their high number of publications include the University of Minnesota, the University of Hong Kong, and Peking University.

These results underline the extensive global involvement in the research area under review, with countries such as China, the USA, Russia and England playing a leading role. Also, the identification of institutions such as the University of Minnesota, the University of Hong Kong, and Peking University suggests that these entities have made significant contributions to the literature in this field. This co-authored analysis provides clear insight into the geographic and institutional distribution of research in the area of interest.

In research conducted with the bibliometric analysis of Fintech, it is important to recognize and manage limitations to ensure the integrity and validity of the results. Apart from the short period of time and the small number of analysed results, including the use of a limited number of bibliographic sources and the specific selection of some sources that can lead to a partial view of the field.

And as future directions we propose to consult other databases, such as Scopus, it can make a significant contribution to amplifying the perspectives and deepening the analysis in the field of Fintech.

In conclusion, the bibliometric analysis reveals a diverse and dynamic landscape of research in the analysed field, highlighting the significant contributions of certain countries, authors and institutions. This detailed understanding of collaborative networks and relevant impact factors provides a solid foundation for future research orientation and identification of priority directions in this ever-evolving field.

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