Bibliometric Analysis of Blockchain Technology in Finance

Análisis bibliométrico sobre la tecnología Blockchain en las finanzas

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Abstract

Context: This research addresses one of the technologies that have been successfully applied in the financial sector: Blockchain. While this technology is not yet widely adopted in finance, an increasing number of proof-of-concept projects are being conducted to get closer to its massive implementation. This highlights the importance of studying Blockchain technology in finance. Therefore, the aim of this research is to conduct a bibliometric study that evaluates the advances in the literature from objective aspects.

Methodoly: The present study is classified as quantitative and descriptive because it analyzes the scientific production related to Blockchain technology in finance. Bibliometrics were applied in order to demonstrate the progress of scientific production on Blockchain technology in finance, using data registered in the Scopus database.

Results: Quantitative and qualitative results were obtained in which aspects such as the source, subject area, the number of documents published per year, country, and the most prolific authors were evaluated, in addition to an analysis of word co-occurrence and co- authorship. A total of 596 publications were identified with which a bibliometric analysis was carried out and the free software VOSviewer was used to examine the different maps of co-authorship and word co-occurrence networks.

Conclusions: It is concluded that publications are scarce compared to other technologies that are part of the digital revolution. However, proof-of-concept projects in various financial services are increasing, making it imperative to continue researching their applications, regulation, and risks. As a result, scientific production is expected to grow.

Keywords: digitization, accounting, bitcoin, transactions, finance, blockchain.

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Resumen

Contexto: Esta investigación aborda una de las tecnologías que se han aplicado exitosamente en el sector financiero: Blockchain. A pesar de que en la actualidad esta tecnología aún no se utiliza de forma generalizada en el área de finanzas, cada vez son más las pruebas de concepto que se realizan para acercarse a la implementación de forma masiva. Lo anterior evidencia la importancia del estudio de la tecnología Blockchain en las finanzas. En este contexto, esta investigación busca realizar un estudio bibliométrico donde se evalúen los avances de la literatura considerando aspectos objetivos.

Metodología: El presente estudio fue tipificado como cuantitativo y descriptivo por tratarse de un análisis de la producción científica sobre la tecnología Blockchain en las finanzas. Se aplicó bibliometría con el fin de evidenciar el avance de la producción científica sobre la tecnología Blockchain en las finanzas, con datos registrados en la base de datos Scopus.

Resultados: Se obtuvieron resultados de tipo cualitativo y cuantitativo en los cuales se evalúan aspectos como el número de documentos publicados por año, la fuente, área temática, país y autores más prolíficos, además de un análisis de concurrencia de palabras y coautoría. Se hallaron 596 publicaciones con las cuales se hizo un análisis bibliométrico y se utilizó el programa informático VOSviewer para examinar los diferentes mapas de redes de coautoría y de coocurrencia de palabras.

Conclusiones: Se concluye que las publicaciones son escasas en comparación con otras tecnologías que hacen parte de la revolución digital. No obstante, cada día aumentan las pruebas de concepto en varios servicios financieros, haciendo imperativo seguir investigando sobre sus aplicaciones, regulación y riesgos. Como resultado, se espera un incremento en la producción científica sobre el tema.

Palabras clave: digitalización, contabilidad, bitcoin, transacciones, finanzas, Blockchain

Introduction

In the First Industrial Revolution, manual production was supplanted by industrial production. The main technological advance that made this possible was the steam engine (Deane & Solé-Tura, 1977). A century later, during the Second Industrial Revolution, steam was replaced by electricity, resulting in the invention of the internal combustion engine, the incandescent lamp, and the electric telegraph, among others (Domínguez, 2020). In the late 1960s, the Third Industrial Revolution began, and it is ongoing. The most notable milestones included the development of personal computers and renewable energy. New means of communication emerged, and new industries, such as computing and the service-oriented economy, were established. Science and technology underwent significant breakthroughs (Rifkin, 2011).

We are witnessing the Fourth Industrial Revolution, which began at the start of the 21st century. This revolution is characterized by ubiquitous, mobile internet and smaller, more powerful, and increasingly cost-effective sensors (Nedelkoska & Quintini, 2018). Key developments such as Cloud Technology, the Internet of Things, Big Data, Analytics (Suárez & Ladino, 2022), RPA, Blockchain (Muñoz-Romero *et al.*, 2022, Pava *et al*, 2021), among others, are transforming the business sector (Schwab, 2016). However, not all technologies that are part of the digital re-

volution and are reshaping the global economy have been applied to the financial sector. This research focuses on one such technology—Blockchain—that has been successfully adopted in the financial industry. Blockchain is a decentralized, continuously linked record that stores the accounting ledger of direct cryptocurrency exchanges between users (Karp, 2017).

The applications of Blockchain technology in the financial sector are diverse. For example, in banking, it is used in conjunction with Artificial Intelligence (AI) to facilitate the opening of savings accounts or the issuance of credit cards, as well as to reduce response times for mortgage loans. In the insurance industry, smart contracts make it possible to establish, monitor, and enforce the conditions necessary for transactions to be executed (Deloitte, 2017). Similarly, Blockchain shows great potential for creating accounting systems that manage the secure purchase and sale of shares in financial markets (Bruskin *et al.*, 2017). The applications of Blockchain are varied, and by 2015, discussions about its potential had gained significant popularity, establishing itself as a mainstream technology that is no longer limited to small groups but has also reached the general public. As a result, scientific production on the subject has increased (Iansiti & Lakhani, 2017).

In this sense, the financial sector faces a challenge, as this technology is not yet widely adopted. However, an increasing number of proof-of-concept projects are being conducted, bringing us closer to large-scale implementation (Albort-Morant & Ribeiro-Soriano, 2016). This highlights the importance of studying Blockchain technology in finance, which is why numerous studies on this subject are present in the literature. For instance, Firdaus *et al.* (2019) conducted a bibliometric analysis of Blockchain worldwide and argued that it will continue to be a growing trend in the future. Likewise, Kuzior and Sira (2022) presented a comprehensive bibliometric study of Blockchain. Their research contributes to improving review quality by guiding researchers to the most significant documents and mapping key areas of publications.

Building on previous bibliometric studies, this research aims to further explore the literature on Blockchain technology in finance. The study set out to conduct a bibliometric analysis to assess the progress of the literature from objective perspectives. To achieve this, 596 publications on Blockchain in finance, sourced from the Scopus database, were examined. The study covers the period from 2016, when the first documents on the subject were registered, to 2019. It considers both quantity and quality indicators of the content and analyzes networks of co-authorship and keyword co-occurrence. This study will serve as a guide for understanding the advancement of scientific production on Blockchain.

Methodology

This study was classified as quantitative and descriptive, as it involved an analysis of the scientific production of Blockchain technology in finance. To achieve this objective, bibliometrics were employed, a method that measures the literature by taking into account various aspects (Castillo *et al.*, 2017). Bibliometrics enables the evaluation and analysis of academic research output in a specific field and contributes to the advancement of science in several ways: it assesses progress, identifies the most reliable sources of scientific publications, highlights key scientific contributors, and establishes the academic bases for the evaluation of new developments, among others (Cascón-Katchadourian *et al.*, 2020).

In this context, indicators were used to assess the scientific production of the authors, bibliographic references or citations, number of authors, the annual trends in articles published during the indicated period, leading journals, primary disciplines, study types, number of citations per article, co-authorship and keyword co-occurrence. All articles from the Scopus database were selected within the period 2016-2020, following the search algorithm: TITLE-ABS-KEY (Blockchain AND finance) AND PUBYEAR >2015 AND PUBYEAR <2021.

Likewise, VOSViewer software was used to analyze co-authorship, bibliographic coupling, keyword co-occurrence, and citations in bibliometric metadata. Bibliographic coupling was based on the identification of shared references, that is, when the same publication is referenced by two different sources. On the other hand, keyword co-occurrence analysis revealed how the field has evolved over time (Deng & Xia, 2020). This technique is effective for identifying the most relevant topics in a given domain. In addition, citation analysis made it possible to detect popular topics and research articles that other researchers are working on (Lai, 2020). The results obtained were presented in the form of a table or network visualization map.

Results

This section describes the obtained results. The general analysis was conducted considering five aspects: the number of documents published per year, authors, sources, country, and subject area. Additionally, an analysis of keyword co-occurrence and co- authorship was performed. The bibliometric analysis resulted in the following: the search equation entered into the Scopus database showed a total of 596 documents between the years 2016-2020. It should be noted that no documents before 2016 on Blockchain in the financial area were found. This is because it is a technology that emerged during the Fourth Industrial Revolution to reduce costs considered unnecessary in transactions and that limited online operations (Nakamoto, 2008).

As can be seen in Figure **1**, 13 documents were found in 2016, 49 in 2017, 120 in 2018, 209 in 2019, and 205 in 2020, for a total of 596 documents. The results indicate a growing number of publications, where 2018 seeing more than double the number of publications compared to 2017. Although 2019 also saw an increase, it did not quite reach double the number of publications from 2018, but it was close. This suggests a growing interest and attention towards this technology in the academic, scientific, or business fields. The significant increase in 2018 compared to the previous year indicates a turning point in the recognition and study of Blockchain. This increase could be related to a greater understanding of the applications and potential of the technology, which in turn stimulated more research and the publication of related documents.
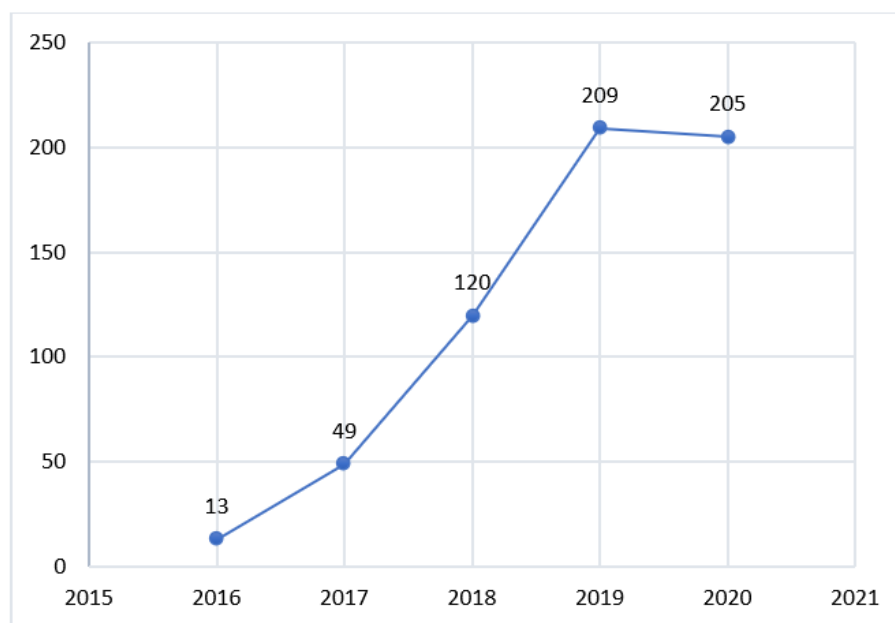

Figure 1. Number of documents per year
Source: Authors based on SCOPUS data

However, publications on Blockchain are scarce compared to other technologies that are part of the digital revolution. This suggests that, although there has been a growth in interest in Blockchain, there is still scope for further research and development compared to other technological areas. According to Corredor and Díaz (2018), this result may stem from the fact that Blockchain applications, both in general and in finance, are still in development due to the potential advancements this technology offers.

As for the authors, the most prominent according to the number of publications include Lee Kuo Chuen, with 5 documents—2 are books and 3 book chapters—and Owen, with 4 publications. Following them, several authors have 3 publications each, as seen in Figure **2**.
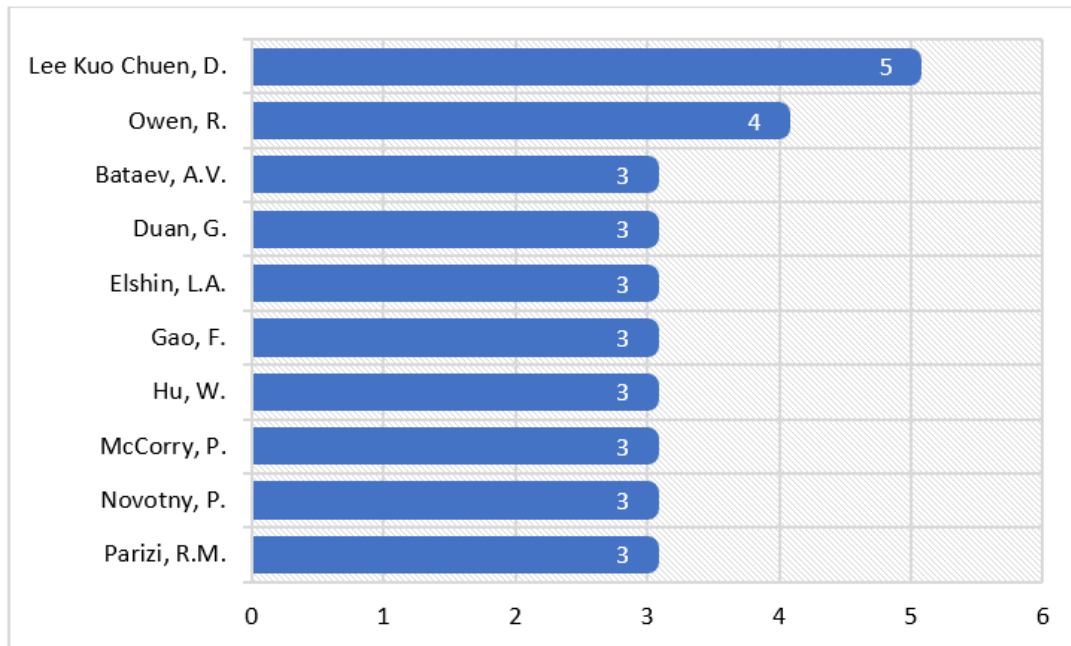
Figure 2. The ten most prolific authors on Blockchain in finance
Source: Authors based on SCOPUS data

On the other hand, the analysis of authorship revealed that, although Lee Kuo has the highest number of published documents on the subject studied, he has fewer citations compared to McCorry, who has the highest number of citations and a higher h-index, as seen in Table 1. The h-index measures the correspondence between the number of documents produced by an author and the number of citations those documents have received; it is a commonly used indicator in bibliometrics (Azanar & Guerrero, 2011). Lee Kuo has a total of 11 published documents, which have been cited 36 times. The author with the highest h-index found in this study is Parizi, with an h-index of 13, followed by McCorry with 9 and Gao with 6, although the latter has not yet received citations for these documents. Parizi has a total of 78 documents and has been cited 432 times, which explains why this author has the highest h-index. This suggests that McCorry and Parizi have a greater impact and recognition in the academic community concerning the subject studied, as reflected in their higher h-indices and the greater number of citations.

Regarding the thematic areas, Computer Science predominates with 29 %, followed by Engineering with 14 %, and Business, Management, and Accounting with 13 %, as shown in Figure **3**. This distribution occurs because Blockchain is a technology of the Fourth Industrial Revolution, also known as the Digital Revolution, which is directly related to Computer Science and Engineering.

Table 1. Authors with the highest number of publications

Author	Country	Documents	Quotes	H index
Lee Kuo Chuen, D.	Singapore, United States, and China	5	13	4
Owen, R.	United Kingdom, Ireland	4	10	4
Bataev, A.V.	Russia	3	0	7
Duan, G.	China	3	0	4
Elshin, L.A.	Russia	3	0	5
Gao, F.	China	3	40	6
Hu, W.	China	3	0	3
McCorry, P.	United Kingdom, Netherlands, Austria, and Switzerland	3	107	9
Novotny, P.	United States, Germany, Canada, and Switzerland	3	12	3
Parizi, R.M.	United States, United Kingdom, and India	3	78	13

Source: Authors based on SCOPUS data

These results show that the dominant subject areas in Blockchain-related documents are Computer Science, Engineering and Business, Management, and Accounting. This is consistent with the nature of Blockchain as a technology of the digital revolution that encompasses both technical and business aspects. According to Daniel *et al.* (2017), these areas predominate due to the direct connection between Blockchain and these fields, such as Economics, Econometrics, and Finance, as this technology provides a secure way to exchange various types of goods, transactions, or services.

Regarding the source of publication in Figure **4**, five main sources are observed, with Lecture Notes in Computer Science (including its subseries *Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics*) publishing 49 documents. This journal, published by Springer Nature, has an SJR index of 0.427. The SJR (SCImago Journal Rank) is an indicator used to assess the quality of scientific publications, based on the number of citations each publication receives (Deusto, 2020).

According to Figure **4** and Table 2, the journal with the highest SJR score was *IEEE Access*. However, the number of publications made, totaling 6, is much lower compared to the next highest-ranked journal in the SJR score. This means that the source that receives the most citations from this group is *IEE Access*, followed by *Lecture Notes in Computer Science*, including its subseries *Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics*.
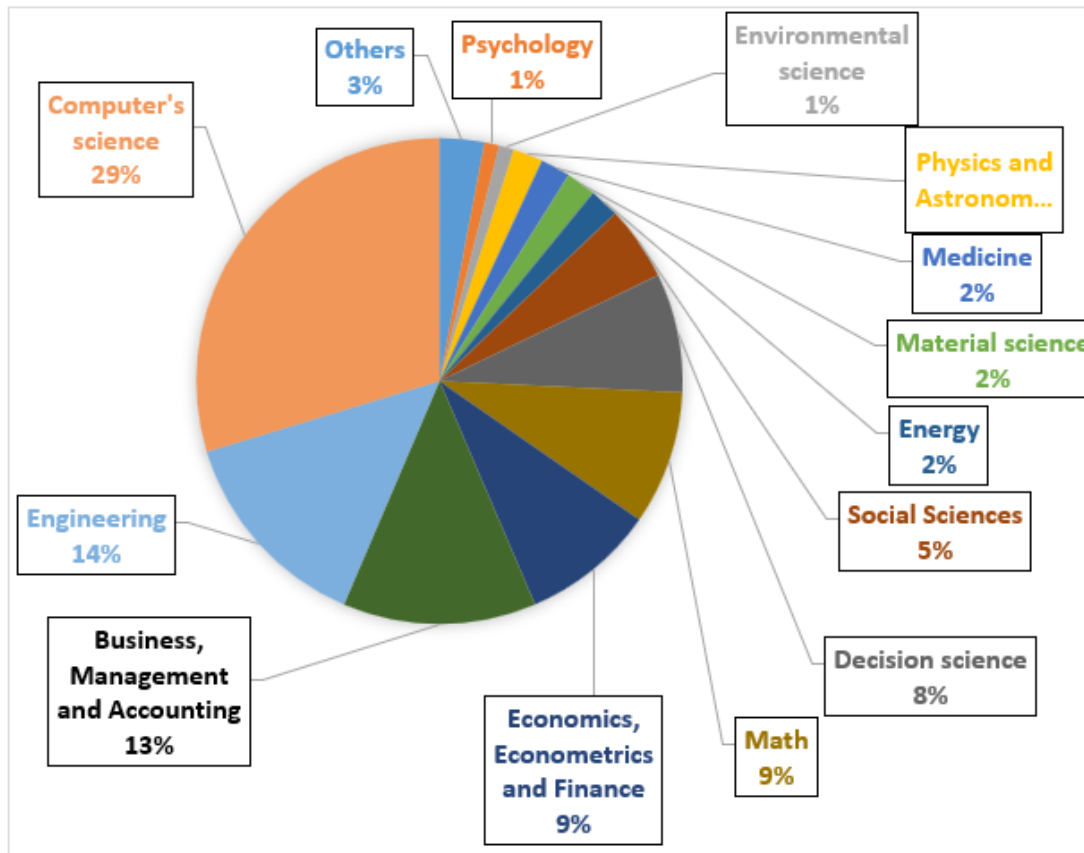
Figure 3. Thematic areas of the documents published on Blockchain in finance
Source: Authors based on SCOPUS data

Regarding the countries that present the highest scientific production on Blockchain in finance, China takes the first position with 140 publications, followed by the United States with 104, the United Kingdom with 59, India with 52, and Russia with 35, as seen in Figure **5** and Table 3.

On the other hand, a co-authorship analysis was conducted using VOSviewer software, which revealed collaboration between some countries, as shown in Figure **6**. The scientific collaboration analysis provides clear and objective information that supports decision-making because it allows analyzing the relation that exists between the elements of a given environment (González & Gómez, 2014). In this case, the behavior of collaboration between some countries was observed.

The proximity between the nodes of China, United States, and United Kingdom suggests collaboration between authors from these countries, which helps explain why they have the

Table 2. Specific data of the magazines that publish the most on Blockchain technology in finance

| Source	2016	2017	2018	2019	2020	Documents	SJR
Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	2	4	8	6	29	49	0,427
ACM International Conference Proceeding Series	-	1	4	10	10	25	0,200
Advances in Intelligent Systems and Computing	-	-	-	3	10	13	0,184
IEEE Access	-	1	1	5	2	9	0,775
Communications in Computer and Information Science	-	-	-	3	3	6	0,188

Source: Authors based on SCOPUS data
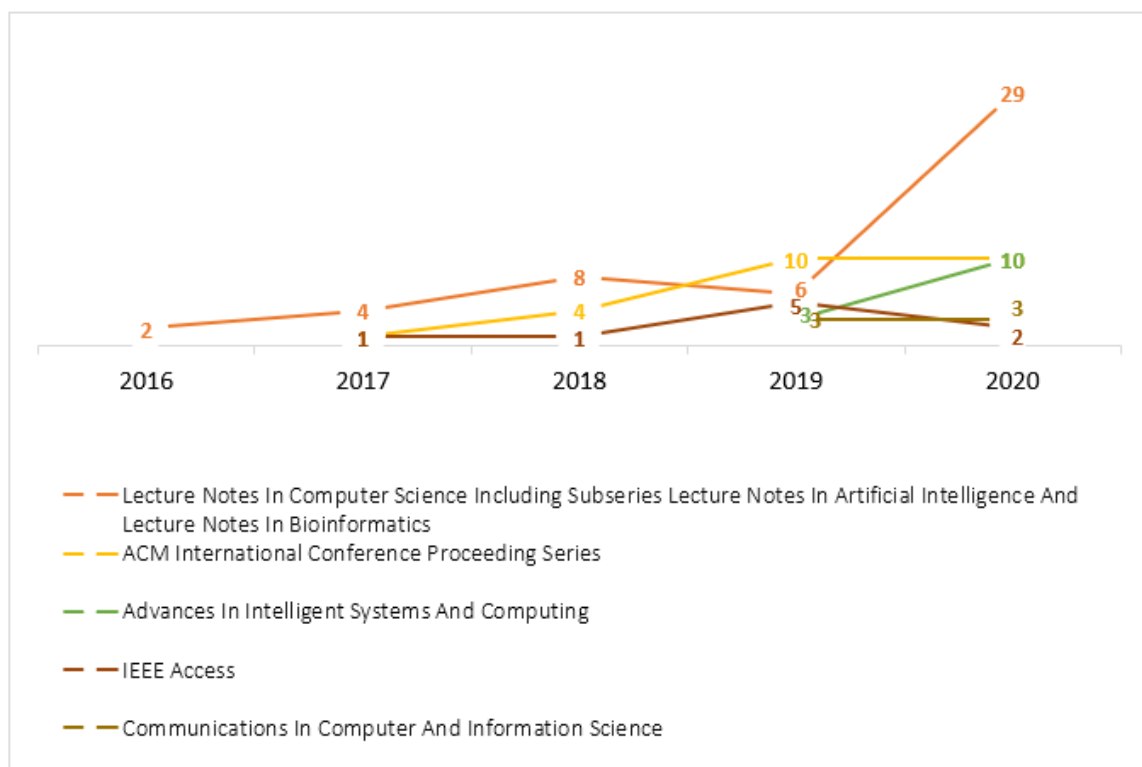
Figure 4. Journals that publish the most about Blockchain technology in finance

Source: Authors based on SCOPUS data
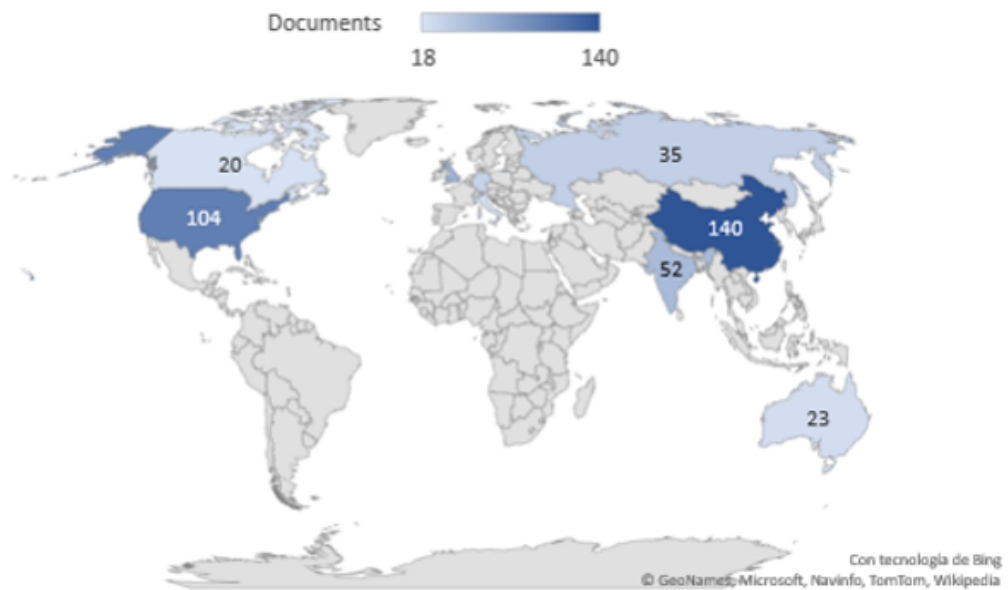
Figure 5. Countries with the largest publications on Blockchain in Finance
Source: Authors based on SCOPUS data

Table 3. Number of documents by countries with the largest publications on Blockchain in Finance

Country	Documents
China	140
United States	104
United Kingdom	59
India	52
Russia	35
Germany	32
Australia	23
Italy	21
Canada	20
Singapore	18

Source: Authors based on SCOPUS data

largest number of publications on the subject of study. This collaboration allows for the determination of elements such as size, structure, and composition of the research groups, which can influence their performance and efficiency (Almero, 2011).

Figure 6. Co-authorship analysis
Source: Authors based on SCOPUS data

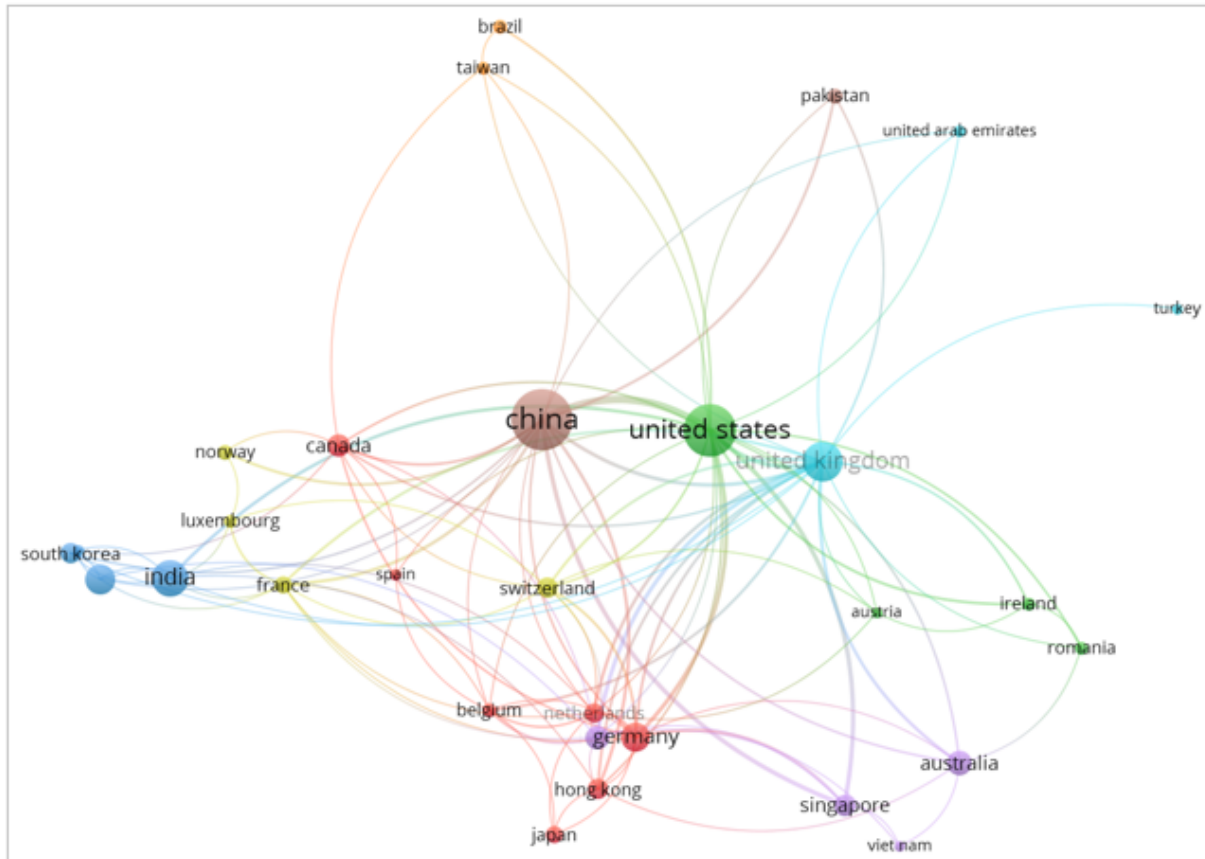On the other hand, the word co-occurrence analysis (Figure **7**) revealed that the words "Blockchain" and "Block-chain" are used differently, and therefore, they are located in different clusters. As a result, six clusters were obtained in which the keyword "Blockchain" concentrates the greatest force, followed by "finance", and "bitcoin." The latter has a direct relation with "Blockchain" due to the proximity between its nodes, as well as the keywords "Internet of Things," "cryptography," and "smart contracts," as seen in Figure **7**. Regarding the clusters of keywords, three groups were formed:

In the first cluster (in red color), the main keywords are grouped, characterized by a high link strength with the subject analyzed in this study. In the second cluster (in navy blue color), the keywords related to Blockchain were grouped, mainly "Bitcoin," "smart contract," among others. "Bitcoin" was the central term of this cluster, representing an important relation with "Blockchain." Conversely, the words "disruptive technology" and "Hyperledger", showed weak link strength but a strong relation with the other keywords. The third cluster
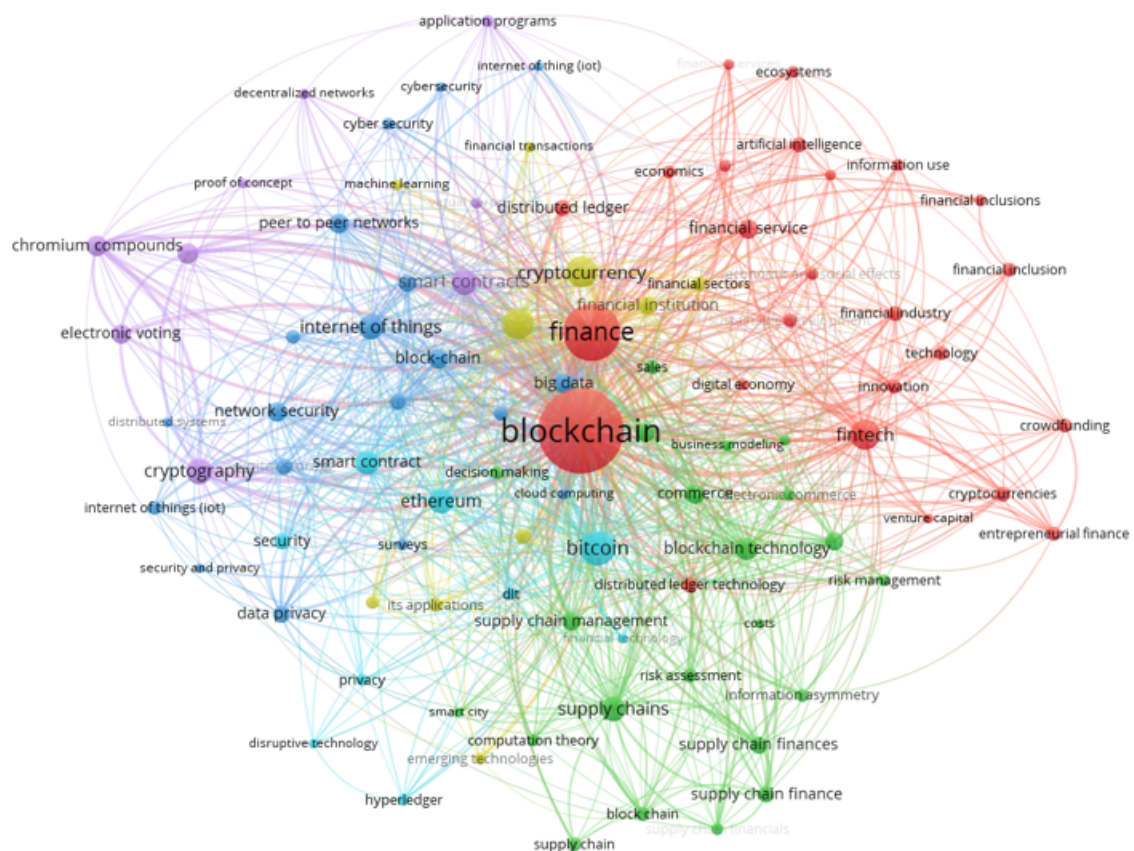
(in blue) consists of words such as "Block-chain" and "network security," which are related to the "Internet of Things," where the strength of this cluster is centered. The fourth cluster (in green) is made up of the words "Block-chain technology," "supply chains," "supply chain management," among others. The fifth cluster (in yellow) groups the words "cryptocurrency", "financial sectors", and "financial institution." Their closeness to the strongest keywords indicates that they are directly related. Finally, the sixth cluster (in violet color) groups together "cryptography," "smart counters," "chromium compounds," which, due to the size of their nodes, have the greatest strength within the cluster.

Figure 7. Keyword co-occurrence network map
Source: Authors based on SCOPUS data

Regarding the timeline of the progress of the keywords, the VOSviewer software indicates that the nodes in yellow are the most used recently. According to the results, the keywords related to the subject studied include, among others, supply chain finances, electronic voting, costs, and chromium compounds, as seen in Figure **8**.

Figure 8. Keyword timeline
Source: Authors based on SCOPUS data

Conclusions

The bibliometric analysis reveals that, while there are documents related to the financial Blockchain, their quantity is relatively low compared to other technologies of the Digital Revolution. This indicates that, although interest in Blockchain is evident, there is still significant potential for further development and exploration in this area.

Regarding the authors, it is worth noting that the number of documents published does not necessarily correlate directly with their academic impact. In other words, some authors may have a large volume of publications but not necessarily a high h-index, which measures influence based on citations received. On the other hand, authors with fewer papers may have a high h-index, suggesting that their contributions have been widely recognized and cited within the academic community. This highlights the importance of the quality and relevance of the jobs rather than just the quantity.

In terms of subject areas, it is observed that Blockchain in finance is closely related to Computer Science and Engineering. This is because Blockchain is a technology associated with the Digital Age, and its implementation requires strong technical knowledge in these areas. These connections highlight the need for specialized skills to develop, implement, and manage solutions based on this technology.

The collaboration between countries such as China, the United Kingdom, and the United States in research on Blockchain underscores the importance of international cooperation in this field. These countries, as leaders in the production of documents on the subject, are promoting research and knowledge related to Blockchain.

Although the widespread use of the Blockchain in the financial sector has not yet been reached, an increase in proofs of concept is observed in various financial services. This indicates that efforts are being made to explore and take advantage of the potential of this technology in the financial field. As research on its applications, regulation, and risks progresses, it is expected that scientific output will increase and the adoption of Blockchain in the financial sector will expand.

In summary, the need to continue researching and developing the field of Blockchain in the financial environment is emphasized. Although progress has been made, there remain opportunities for further exploration and application in this area. The quality and relevance of the work are essential, and international collaboration is crucial for progress. As challenges are overcome and research advances, further adoption of Blockchain in the financial sector is expected, with the potential to transform the industry.

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