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Blockchain in banking and finance: A bibliometric review

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ABSTRACT

Blockchain is a disruptive, decentralized, replicable, distributed ledger technology with the potential to change the conventional business landscape in banking and finance. This study consists of a bibliometric review and a content analysis of the academic literature dealing with the antecedents, the applications, and the consequences of the adoption of blockchain-based technologies in these highly interconnected industries. With a final sample of 154 papers published between 2009 and 2021, we map their influential aspects, in terms of trending topic, authors and target journals. We then provide a bibliographic analysis, which consists of co-authorship, cartographic, co-citation and coupling analyses. Finally, we identify the main literature streams and the future research agenda, which may serve as a valid starting point for future research in the field for both scholars and practitioners.

1. Introduction

Blockchain is a decentralized, replicable, distributed ledger technology that underlies many incremental and disruptive innovations. Blockchain technology relies on algorithmic blocks containing transaction information, which are connected and validated in chronological order and form a chain that contains permanent, immutable, transparent, and tamper-proof records (Guerar et al., 2020). According to the extant literature, five defining elements characterise blockchain (Chang et al., 2020): (1) Computational Logic, which means that blockchain transactions can be automatically activated by algorithms. So, in a nutshell smart contracts designed on a blockchain can be programmed so that they automatically perform transactions between nodes; (2) Decentralisation, which allows direct peer to peer transactions without the need for a central node; (3) Irreversibility of Records, which implies that the record of a transaction is immutable and is part of a chain that organises all transactions in chronological order; (4) Distributed Database that cannot be controlled by a single individual but, on the contrary, can be modified by adding new transactions and validated by participants; (5) Transparency with Pseudonym allows transactions to be transparent and visible on the blockchain by any participant but at the same time each node can decide whether to provide its identity details or use a pseudonym.

These characteristics ensure all blockchain-based technologies to decrease transaction costs dramatically, together with execution times. Moreover, distributed ledger technologies do not need intermediaries or trusted third party to validate the transactions. This decentralised, digital technology is applicable to virtually any industry, and has the potential to be a disruptive innovation, so much that the advent of blockchain-based solutions has started the so-called Fourth Industrial Revolution, or Industry 4.0. Naturally,

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distributed ledger technologies have a huge and direct impact on computer science, but they also have been applied successfully to engineering and energy management, figurative arts, social sciences and business management. Another two highly connected industries that have been deeply affected by blockchain are banking and finance, the focus of this bibliometric analysis. In the last fifteen years, this technology has proven to be potentially able to reshape the way modern finance is organised, in terms of intermediaries' role and organisation, means of payment, payment transactions, asset management, clearing and settlement processes, real estate deals management, insurance contracts, public procurement and many more (Mills et al., 2017). Are banks ready to this change? The literature does not seem to be unanimous on this regard; on the one hand (e.g., [Barrdear and Kumhof, 2021](#); [Saheb and Mamaghani, 2021](#)), scholars maintain that the competitive nature of the banking industry has inclined many intermediaries to adopt these new technologies to internalise potential competition, on the other (e.g., [Cukierman, 2020](#); [Erol et al., 2020](#); [Mohsin et al., 2020](#)) though, some scholars identify strong technological, organizational, educational, and environmental barriers that may hinder blockchain diffusion in banking and finance. Interestingly, [Rahman and Abedin \(2021\)](#) try to assess the perception and readiness to the Fourth Industrial Revolution of the Bangladeshi commercial banking sector. The results, although not directly extendible to the banking industry as a whole, point out that the readiness of the banking sector is only in a "preliminary stage" and that deep changing to the banking business model are required to accommodate the new technological innovations. Nonetheless, the results of a behavioural survey on blockchain-based services users (i.e., [Nikbakht et al., 2019](#)), shows that the knowledge and awareness, the value-added for end users, and the institutions' willingness to adopt these new blockchain applications are significantly higher for the financial sector, compared to others. Finally, the COVID-19 pandemic has acted as a catalyst for the adoption of distributed ledger technologies both by highlighting the infrastructural deficiencies of the traditional banking system and by paving the way for digital financial solutions that do not involve direct interaction with the customers (e.g., [Dicuonzo et al., 2021](#); [Nor et al., 2021](#)). The timing, the growing trend, and the potential magnitude of the consequences of massive blockchain adoption in banking and finance, has attracted a great deal of attention, including among scholars. In the last few years, the related literature has boomed (see paragraph 3) and provided extensive but fragmented contributions. This paper aims to provide a bibliometric review and a content analysis on the antecedents, consequences, and applications of blockchain technology in banking and finance and provide a possible future research agenda. The wide perspective we adopted to select the articles in our review allows us to consider contributions at individual-level (e.g., [Gurdgiev and O'Loughlin, 2020](#)), firm-level (e.g. [Cioroianu et al., 2021](#)) and industry-level (e.g. [Osmani et al., 2020](#)).

To the best of our knowledge, this is the first contribution of this kind, even though there are some papers that are close to ours in some respects. For instance, there are several generalist bibliometric reviews (e.g., [Firdaus et al., 2019](#); [Grover et al., 2019](#)) that contribute to the literature by exploring the blockchain technology diffusion in different industries. [Grover et al. \(2019\)](#) use a combination of academic literature and social media content as an input, whereas [Firdaus et al. \(2019\)](#) resort to Scopus database for their review. In these cases, the research generically aims to find which industries are exploring blockchain technology applications, how this technology has been adopted or has contributed to the different industries.

These differences in terms of perspective and methodology deeply differentiate our contribution to those just mentioned; for instance, the keywords that emerge from the word-cloud by [Firdaus et al. \(2019\)](#), includes broader terms compared to ours (see par. 4.2), such as "cryptography", "p2p networks", "internet of things", "big data" or "digital storage", but also "electronic money" and "bitcoin", which shows the centrality of blockchain applications in the banking and financial industry.

The literature also provides other contributions that are more focused on banking and/or finance, like ours, but what differentiate them from our bibliometric review is that they are either qualitative thematic analysis either on blockchain (e.g., [Q. Gan et al., 2021](#); [J. Gan et al., 2021](#)) or on FinTech generally speaking (e.g., [Thakor, 2020](#)), or they are specifically focused on a single blockchain applications, for instance Bitcoin, as in [Flori \(2019\)](#).

Therefore, combining qualitative and quantitative methodologies (i.e., a bibliometric review accompanied by a content analysis) on the academic contributions regarding antecedents, applications and consequences of blockchain technology in banking and finance, we aim to contribute to the literature and to provide a valid starting point for future research by discussing some unanswered research questions.

The remainder of the paper is organized as follows: [Section 2](#) provides an in-depth description of the methodological approach adopted, whereas [Section 3](#) presents the sample and its characteristics. [Section 4](#) shows the results of some bibliometric analyses, [Section 5](#) presents the research streams that constitute the literature under examination and [Section 6](#) suggests future research agendas. Finally, [Section 7](#) provides some concluding remarks.

2. Methodology

2.1. Sample selection process

We have selected the sample using a three-step process. In the first step, we identify our sample of papers based on searches on the Elsevier Scopus database and the ISI Web of Science (WOS) database. Scopus database is especially well suited for bibliometric studies (e.g. [Ball and Tunger, 2006](#); [Feng et al., 2017](#); [Parlina et al., 2020](#)) because of its extensive coverage of several publishers and fields of study ([Vieira and Gomes, 2009](#)). The ISI WoS is a wide database including other five databases and covering all the top journals since 1950. We identified the articles based on the search-words "blockchain in bank*", "blockchain technology in bank*", "blockchain in financ*", "blockchain technology in financ*" appearing in any order in article's title, and/or abstract, and/or keywords. The search was made for the articles, written in English, to ensure a better understandability and published between 2008, when the first blockchain was conceptualised by Satoshi Nakamoto ([Satoshi, 2008](#)) and the end of 2021. We have selected only peer-reviewed articles, and avoided working papers, conference papers, notes etc. The search using these search-words led to 1626 articles from both

Scopus and Web of Science databases. In the second step, we removed the duplicate articles, which left us with 936 articles. In order to examine the suitability of the sample for the review, each paper has been examined in terms of relevance to the topic by an author, who read and reviewed the abstract of each paper and retained 379 articles for further consideration. In the third step in order to ensure some quality standards, the sample has been filtered to only retain journals listed in the *2021 Academic Journal Guide of the Chartered Association of Business Schools* (ABS) ranking. In this phase, those articles which are published in non-ABS ranked journals are dropped, which left us with a final sample of 154 articles.

2.2. Meta-literature review

We perform the Meta-literature review by focusing on the quantitative aspect of the bibliometric citations. Our analysis focuses on the 1) Publication trend, 2) Influential countries, 3) Influential journals, 4) Influential authors, 5) Influential articles, 6) Co-authorships visualization, 7) Cartographic analysis, 8) Co-citation analysis, 9) Influential institutions and 10) Bibliographic coupling analysis, as presented in paragraph 3.

3. The sample and its influential aspects

3.1. Publication trend

The number of publications per year during our sample period is reported in Fig. 1, where the X-axis shows the years from 2017 to 2021¹ and the Y-axis shows the number of published papers. The figure shows that the research output on blockchain in banking and finance increased year-over-year. The number of papers were very few until 2018. However, from 2019 scholars from banking and finance have steadily intensified their interest in blockchain, which results in a substantial increase in the number of papers. In years 2019, 2020, 2021, 18, 48 and 73 papers respectively were published in ABS journals.

3.2. Influential countries

Table 1 shows countries with the highest number of papers on blockchain in banking and finance. The early studies are mainly conducted by researchers from developed countries, such as United States, United Kingdom, Germany, Italy, Netherlands, France, Australia, Belgium and Hong Kong, with some studies from the emerging markets such as China and India. Most studies are conducted by research groups from developed countries, but the researchers from emerging markets have also started working in this area. However, the topic of blockchain in banking and finance is yet to be explored in depth by the researchers from emerging and frontier countries.

Table 2 reports the countries with highest and lowest citations levels. The studies with highest citations are based in North America and European countries, except for China and Singapore. The studies conducted by the researchers from the Cyprus, Indonesia, Portugal, Romania, Malaysia, Vietnam, Bangladesh, Finland, Israel, Egypt and Iran are the least cited in the field, to date. Table 3 reports highest and lowest per paper citations at country-level. North and South America, European countries and Australia have the highest per paper citations, whereas Asian, African and some small European countries have the lowest per paper citation.

3.3. Influential journals and authors

We identify influential journals and authors using Vosviewer. Table 4 shows the top influential journals based on (1) number of papers, (2) citations, and (3) citations per paper. According to the number of publications, *Technological Forecasting and Social Change*, *Managerial Finance*, *Small Business Economics*, *European Journal of Finance*, *Finance Research Letters*, *IEEE Transactions on Engineering Management*, *International Journal of Finance and Economics*, *Journal of Enterprise Information Management*, *Management Science*, *Accounting and Finance*, *Electronic Commerce Research and Applications*, *International Journal of Information Management*, *Journal of Alternative Investments*, *Journal of Corporate Finance*, *Journal of Property Investment and Finance*, *Research in International Business and Finance* and *Technology Analysis and Strategic Management* have the highest number of published papers related to blockchain in banking and finance.

As reported in Table 4, in terms of total number of citations the top 5 journals are the *Computer Journal*, *Journal of Management Information Systems*, *Journal of Business Venturing and Review of Financial Studies*, which is not included in the list of journals with the highest number of papers published. The *Technological Forecasting and Social Change* is the only journal which has both a high number of papers and a high number of citations. In terms of per paper citations, *The Computer*, *Journal of Business Venturing*, *Review of Financial Studies* are the top journals, with the highest per paper citations, even though they do not appear in the list of top journals as per number of papers.

Table 5 shows the influential authors based on (a) numbers of papers, (b) numbers of citations, (c) average citations per paper and (d) number of publications in ABS 4 * journals. Identifying top journals and authors is helpful to researchers to form potential future collaborations (Van Eck and Waltman, 2014). The influential authors analysis provides important insights in this regard. The authors

¹ No article published between 2008 and 2016 meet the filters applied and described in paragraph 2.

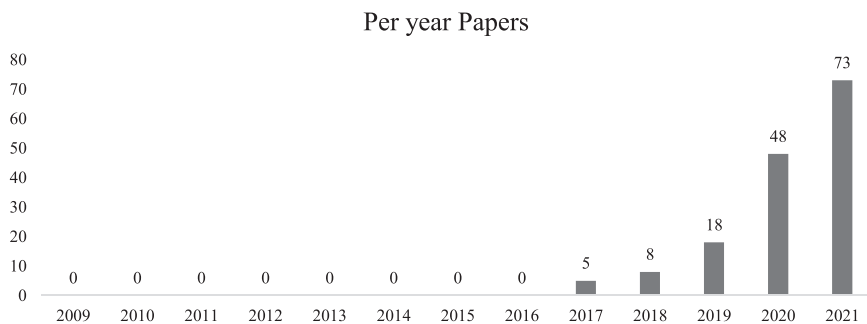


Fig. 1. Number of papers published over the years, Annual articles on blockchain technology in banking and finance meeting the sample selection criteria published over the period 2009–2021.
Source: Authors’ elaboration.

Table 1
Countries with highest papers production.

Country	# Papers
United States	48
United Kingdom	28
China	27
Germany	18
Italy	13
Netherlands	13
France	10
India	9
Australia	7
Belgium	6
Hong Kong	6

This table shows the countries with highest production of papers in the area of Blockchain technology. Table shows the number of published papers in ABS ranked journals 2008–2021.
Source: Authors’ calculation.

Table 2
Countries with highest and lowest citations.

Countries with highest citations			Countries with lowest citations	
R	Country	# Citations	Country	# Citations
1	United States	1213	Cyprus	0
2	Germany	557	Indonesia	0
3	United Kingdom	472	Portugal	0
4	China	394	Romania	0
5	Netherlands	266	Malaysia	0
6	Singapore	244	Vietnam	1
7	Australia	160	Bangladesh	1
8	Belgium	152	Finland	2
9	France	105	Israel	2
10	Italy	103	Egypt	2
11			Iran	2

This table shows the countries with highest and lowest citations of papers in the area of Blockchain technology in banking and finance. The table shows the number of published papers in ABS ranked journals between 2008 and 2021.
Source: Authors’ calculation.

Lennart Ante and Shaen Corbet, Ingo Fiedler and Wolfgang Härdle are the top ones in terms of number of published papers, but none of them fall in the top authors as per citations and per paper citations. Dong Yang, Christian Fisch, Silvio Vismara, Yanyu Chen and Cristiano Bellavitis are the most cited authors in the field, surprisingly Dong Yang, Yanyu Chen and Cristiano Bellavitis have published only two articles related to blockchain in banking and finance. Considering jointly all three parameters (i.e., number of articles, number of citations, and citations per paper), Christian Fisch from Trier University, Germany is the most influential author, with three papers published in ABS Journals, 157 citations and 52.33 average citations per paper. We also identified the influential authors based

Table 3
Countries with highest and lowest per paper citations.

Highest per paper citations			Lowest per paper citations	
R	Country	# citations	Country	# citations
1	Mexico	71.00	Cyprus	0.00
2	Singapore	48.80	Indonesia	0.00
3	Denmark	40.00	Portugal	0.00
4	Brazil	38.00	Romania	0.00
5	Germany	30.94	Malaysia	0.00
6	Belgium	25.33	Bangladesh	0.50
7	United States	25.27	Vietnam	1.00
8	Australia	22.86	Egypt	1.00
9	Chile	20.50	Iran	1.00
10	Netherlands	20.46	Greece	1.00

This table shows the countries with highest and lowest per paper citations of papers in the area of Blockchain technology. Table shows the number of published papers in ABS ranked journals over the period 2008–2021. Source: Authors' calculation

on the number of publications in ABS 4 * ranked Journals. According to this criterion, the influential authors are from USA, China, Denmark, Australia, France, Canada, Netherlands and Hungary. Gerry Tsoukalas from the University of Pennsylvania, USA has 2 publications in ABS 4 * Journals where are other 28 authors in the ranking have one publication each in ABS 4 * Journals.

3.4. Influential articles

Table 6 shows the influential and trending articles in the domain of blockchain in banking and finance based on (1) the number of total citations, (2) the average number of citations per year on the overall period and on the two subsamples 2017–19 and 2020–21 and (3) the number of papers in 4-star journal by ABS ranking. Once again, Vosviewer software is used to identify influential and trending articles. Identifying the influential and trending articles can guide scholars in future directions of research, as a highly cited publication typically indicates that it has had or will have a major effect in the respective area (Bahoo et al., 2020). Gomber et al. (2018) in Journal of Management Information Systems is the most cited article with a total of 227 citations in ABS ranked journals and 45.40 average citations per year. The article by Dai J. and Vasarhelyi M.A. (2017) published in Journal of Information Systems has received the second highest number of citations, 196, whereas an article by Fisch (2019) published in Journal of Business Venturing has received the second highest citations per year score (36.75). By splitting the influential articles into the two categories “Initial studies (2017–2019)” and “(2) Recent studies (2020–2021)”, the paper by Su et al. (2020) emerges as the recent most influential publication with an average of almost 31 citations per year. With respect to publication in ABS 4 * Journals, we find that the article by Chod et al. (2020) published in *Management Science*, is the highest in the ranking, with 70 citations. There are also nine influential articles published in ABS 4 * Journals, having citations in *Scopus* between 2 and 70. It is interesting to note that the influential articles have been published over last 4 years, which indicates that the topic is getting attention in top journals, as well. These influential articles are published in *Management Science*, *Review of Financial studies*, *Journal of Finance*, *Journal of the Association for Information systems*, and *Information Systems Research*.

4. Bibliometric analysis

4.1. Co-authorship visualization

Supported by Vosviewer software, we map the co-authorship networks among researchers working on the topic under consideration. VOSviewer takes as an input the number of citations and co-authored articles and gives the outcome in the form of co-authorship network. The co-authorship analysis identifies those researchers who are actively contributing together to the field. The identification of the top networks of authors engaged in blockchain in banking and finance can be useful information for future researchers. The results of co-authorship visual analysis, as reported in Fig. 2 identifies three main research poles. We have also examined the average number of authors per paper. The analysis points out that there are on an average 2.80 authors per paper. Only 30 papers are published by a single author, 32% of the papers are co-authored by two scholars, whereas 23% of the papers are co-authored by three authors and 14% of the paper are written by four authors. Very few papers are co-authored by 5 or more authors. It is interesting to note that, as the research area is quite novel, scholars tend to share their knowledge on the subject and co-author an article, rather than produce a solo-paper.

The international co-authorship by country analysis reported in Fig. 3, is derived according to the number of documents co-authored and the citations received. The co-authorship analysis shows the nationality of the researchers involved in international research groups. 47 countries are included in the co-authorship network with minimum 1 international publication. Authors from the United States of America, the United Kingdom, China, Germany, Netherlands, Italy, France, India, Australia, Belgium, Hong Kong, Singapore, New Zealand, Ireland and Canada are the most active internationally. The international co-authorships are less concentrated among developing countries and small developed countries such as Pakistan, Vietnam, Indonesia and Mexico and Turkey, Poland, Cyprus, Luxemburg, Hungary and Finland.

Table 4
Top Influential Journals.

# Papers		
rank	Journal	papers
1	<i>Technological Forecasting and Social Change</i>	8
2	<i>Managerial Finance</i>	7
3	<i>Small Business Economics</i>	6
4	<i>European Journal of Finance</i>	5
5	<i>Finance Research Letters</i>	5
6	<i>IEEE Transactions on Engineering Management</i>	4
7	<i>International Journal of Finance and Economics</i>	4
8	<i>Journal of Enterprise Information Management</i>	4
9	<i>Management Science</i>	4
10	<i>Accounting and Finance</i>	3
11	<i>Electronic Commerce Research and Applications</i>	3
12	<i>International Journal of Information Management</i>	3
13	<i>Journal of Alternative Investments</i>	3
14	<i>Journal of Corporate Finance</i>	3
15	<i>Journal of Property Investment and Finance</i>	3
16	<i>Research in International Business and Finance</i>	3
17	<i>Technology Analysis and Strategic Management</i>	3
# citations		
rank	Journal	citations
1	<i>Computer</i>	289
2	<i>Journal of Management Information Systems</i>	227
3	<i>Technological Forecasting and Social Change</i>	219
4	<i>Journal of Information Systems</i>	196
5	<i>Journal of Business Venturing</i>	170
6	<i>Review of Financial Studies</i>	100
7	<i>Electronic Commerce Research and Applications</i>	97
8	<i>Small Business Economics</i>	90
9	<i>International Journal of Information Management</i>	79
10	<i>Journal of Financial Intermediation</i>	79
11	<i>Management Science</i>	77
# citations per paper		
rank	journal	citation/paper
1	<i>Computer</i>	144.50
2	<i>Journal of Business Venturing</i>	85.00
3	<i>Review of Financial Studies</i>	50.00
4	<i>Electronic Commerce Research and Applications</i>	32.33
5	<i>Journal of Business Venturing Insights</i>	30.00
6	<i>Technological Forecasting and Social Change</i>	27.38
7	<i>International Journal of Information Management</i>	26.33
8	<i>Accounting and Finance</i>	24.67
9	<i>Management Science</i>	19.25
10	<i>Journal of Risk Finance</i>	16.00
11	<i>Small Business Economics</i>	15
12	<i>Journal of Enterprise Information Management</i>	13.25
13	<i>Ieee Transactions on Engineering Management</i>	10.75
14	<i>Research in International Business and Finance</i>	8.67
15	<i>Strategic Change</i>	8.5

This table shows the top journals as per number of published papers, citations and per paper citations, in ABS ranked journals over the period 2008–2021. Table 4 a shows the journals with 3 or more publications. Table 4b shows the journals with more than 75 citations. Table 4c shows the journals with more than 8 citations per paper.

Source: Authors' calculation.

4.2. Cartographic analysis

As reported in Table 7 and Fig. 4, the cartographic analysis shows the map of keywords based on their occurrence and relevance to blockchain in the banking and financial industries. We used Vosviewer to develop the cartographic analysis, which takes the papers included in our sample as an input and provide a map of keywords, indicating the occurrence of such words as an output. The cartographic analysis facilitates understanding the topics and issues that catalyse researchers' interest. According to Van Eck and Waltman (2010), the co-occurrence of words in papers are examined to assess relatedness. As the articles with the same keywords represent similar directions or streams of research, the cartographic analysis clusters all these keywords together. "Blockchain", "Initial Coin Offering" and "Blockchain Technology" are the most recurrent words in the field of blockchain in banking and finance. Further, the words "Cryptocurrency" and "Impact" frame a cluster; similarly, the words "Cryptocurrency Market" and "Challenge" also construct a cluster. The words such as "Finance", "Blockchain Adoption", "Evidence" and "Entrepreneurial Finance" also appear as top keywords.

Table 5
Influential Authors.

R	Author	Institution	# papers
1	Lennart Ante	University of Hamburg, Germany	3
2	Shaen Corbet	DCU Business School, Ireland	3
3	Ingo Fiedler	University of Hamburg, Germany	3
4	Christian Fisch	Trier University, Germany	3
5	Wolfgang Härdle	Humboldt University of Berlin, Germany	3
6	Silvio Vismara	University of Bergamo, Italy	3
7	Cristiano Bellavitis	University of Auckland Business School, New Zealand	2
8	Yanyu Chen	Zhejiang Normal University, China	2
9	Gerry Tsoukalas	Wharton School of the University of Pennsylvania, United States	2
10	Dong Yang	Renmin University of China, China	2
R	Author	Institution	# citations
1	Dong Yang	Renmin University of China, China	180
2	Christian Fisch	Trier University, Germany	157
3	Silvio Vismara	University of Bergamo, Italy	70
4	Yanyu Chen	Zhejiang Normal University, China	63
5	Cristiano Bellavitis	University of Auckland Business School, New Zealand	60
6	Gerry Tsoukalas	Wharton School of the University of Pennsylvania, United States	57
7	Michele Meoli	University of Bergamo, Italy	48
8	Paul P. Momtaz	University of California, United States	45
9	Xiuping Hua	University of Nottingham Ningbo, China	42
10	Winifred Huang	University of Bath, United Kingdom	40
R	Author	Institution	# citations per paper
1	Dong Yang	Renmin University of China, China	90.00
2	Christian Fisch	Trier University, Germany	52.33
3	Yanyu Chen	Zhejiang Normal University, China	31.50
4	Cristiano Bellavitis	University of Auckland Business School, New Zealand	30.00
5	Gerry Tsoukalas	Wharton School of the University of Pennsylvania, United States	28.50
6	Michele Meoli	University of Bergamo, Italy	24.00
7	Silvio Vismara	University of Bergamo, Italy	23.33
8	Paul P. Momtaz	University of California, United States	22.50
9	Xiuping Hua	University of Nottingham Ningbo, China	21.00
10	Winifred Huang	University of Bath, United Kingdom	20.00
R	Author	Institution	# papers in 4 *ABS Journals
1	Gerry Tsoukalas	University of Pennsylvania, United States	2
2	Alain Yee-Loong Chong	University of Nottingham Ningbo, China	1
3	Amin Shams	The Ohio State University, United States	1
4	Chee Wee Tan	Copenhagen Business School, Denmark	1
5	David L. Yermack	New York University, United States	1
6	Eric Tze Kuan Lim	UNSW Business School, Australia	1
7	Fahad Saleh	Wake Forest University, United States	1
8	Henry Aspegren	Google LLC, United States	1
9	Ioanid Roşu	School of Higher Commercial Studies of Paris, France	1
10	Jingxing Gan	Southern Methodist University, United States	1
11	Jiri Chod	Carroll School of Management, United States	1
12	John M. Griffin	McCombs School of Business, United States	1
13	Jonathan Chiu	Bank of Canada, Canada	1
14	Lin William Cong	Cornell University, United States	1
15	Marina Niessner	AQR Capital Management, United States	1
16	Mark Weber	IBM Watson AI Lab, United States	1
17	Neng Wang	Columbia University, United States	1
18	Nikolaos Trichakis	Massachusetts Institute of Technology, United States	1
19	P. Jean-Jacques Herings	Tilburg University, Netherlands	1
20	P é ter Csóka	Budapesti Corvinus Egyetem, Hungary	1
21	Sabrina T. Howell	Leonard N. Stern School of Business, United States	1
22	Serguei Netessine	University of Pennsylvania, United States	1
23	Shuning Zheng	University of Nottingham Ningbo, China	1
24	Terrence Hendershott	University of California, United States	1
25	Thorsten Koeppl	Queen's University, Canada	1
26	Xiaoquan (Michael) Zhang	Chinese University of Hong Kong, Hong Kong	1
27	Xiuping Hua	University of Nottingham Ningbo, China	1
28	Ye Li	The Ohio State University, United States	1
29	Zhao J. Leon	The Chinese University of Hong Kong, China	1

Table 5 shows the top authors who published in ABS ranked journals in the period 2008–2021. The Table 5a shows the authors with 2 and more publications in ABS ranked journals. The Table 5b shows the authors with 40 and more citations in ABS journals. Table 5c shows the authors with 20 and more citations per paper.

Source: Author's calculation.

Table 6
Influential Articles.

Rank	Article	Journal	Citations
		Overall period	
1	Gomber et al. (2018)	<i>Journal of Management Information Systems</i>	227
2	Dai J. (2017)	<i>Journal of Information Systems</i>	196
3	Treleaven et al. (2017)	<i>Computer</i>	162
4	Fisch (2019)	<i>Journal of Business Venturing</i>	147
5	Eyal (2017)	<i>Computer</i>	127
6	Su et al. (2020)	<i>Technological Forecasting and Social Change</i>	92
7	Thakor (2020)	<i>Journal of Financial Intermediation</i>	79
8	Schuetz s. (2020)	<i>International Journal of Information Management</i>	75
9	Milian et al. (2019)	<i>Electronic Commerce Research & Applications</i>	74
10	Cai c.w. (2018)	<i>Accounting and Finance</i>	71
11	Larios-Hernández (2017)	<i>Business Horizons</i>	71
Overall period			Citations per year
1	Gomber et al. (2018)	<i>Journal of Management Information Systems</i>	45.40
2	Fisch (2019)	<i>Journal of Business Venturing</i>	36.75
3	Dai J. (2017)	<i>Journal of Information Systems</i>	32.67
4	Su et al. (2020)	<i>Technological Forecasting and Social Change</i>	30.67
5	Treleaven et al. (2017)	<i>Computer</i>	27.00
6	Thakor (2020)	<i>Journal of Financial Intermediation</i>	26.33
7	Schuetz (2020)	<i>International Journal of Information Management</i>	25.00
8	Eyal (2017)	<i>Computer</i>	21.17
9	Chen (2020)	<i>Journal of Business Venturing Insights</i>	19.33
10	Milian et al. (2019)	<i>Electronic Commerce Research and Applications</i>	18.50
Initial studies (2017–2019)			Citations per year
1	Gomber et al. (2018)	<i>Journal of Management Information Systems</i>	45.40
2	Fisch (2019)	<i>Journal of Business Venturing</i>	36.75
3	Dai J. (2017)	<i>Journal of Information Systems</i>	32.67
4	Treleaven et al. (2017)	<i>Computer</i>	27.00
5	Eyal (2017)	<i>Computer</i>	21.17
6	Milian et al., (2019)	<i>Electronic Commerce Research and Applications</i>	18.50
Recent studies (2020–2021)			Citations per year
1	Su et al. (2020)	<i>Technological Forecasting and Social Change</i>	30.67
2	Thakor (2020)	<i>Journal of Financial Intermediation</i>	26.33
3	Schuetz (2020)	<i>International Journal of Information Management</i>	25.00
4	Chen (2020)	<i>Journal of Business Venturing Insights</i>	19.33
Publications in ABS 4 * Journals (Overall period)			
1	Chod et al. (2020)	<i>Management Science</i>	70
2	Howell et al. (2020)	<i>Review of Financial Studies</i>	64
3	Chiu and Koepl (2019)	<i>Review of Financial Studies</i>	56
4	Griffin and Shams, (2020)	<i>Journal of Finance</i>	49
5	Chong et al. (2019)	<i>Journal of the Association for Information Systems</i>	45
6	Csóka and Herings (2018)	<i>Management Science</i>	22
7	J. Gan et al. (2021)	<i>Management Science</i>	8
8	Hendershott et al. (2021)	<i>Information Systems Research</i>	7
9	Roşu and Saleh (2021)	<i>Management Science</i>	2

The table shows the Influential Articles based on the citations and per paper citations. The articles with minimum 70 citations and 18 citations per year in ABS ranked journals are included in the list. The label “Initial studies” refers to the papers published between 2017 and 2019, “Recent studies” refers to the studies published between 2020 and 2021.

Source: Author’s calculation.

4.3. Co-citation analysis

Co-citation occurs when two separate publications are cited by a third paper (Small, 1973). The objective of a co-citation analysis is to uncover hidden patterns of author relationships based on their publications (Feng et al., 2017). In the graphical output provided by the software VOSViewer, the co-citation network is represented by lines and the circles (see Fig. 5). The lines between different circles show the streams of co-citations of the papers. The strength of co-citations ties is indicated by the thickness of the nodes. As reported in Fig. 5, the Co-citation Analysis is based on the number of citations each article receives and the link strength of the article. The software VOSviewer presents the output in the form of a diagram, representing the research streams in different colours, that is, red, green, blue and yellow, in our case. The co-citation analysis shows four different clusters of papers, which have been confirmed by the content analysis in paragraph 4.

The eleven top cited publications that are present in the co-citation analysis cluster are reported in Table 8. The papers are ranked based on the number of citations from the ABS journals in our sample. The paper of Fisch (2019), ranked first, is cited by eight other studies in our sample. The paper focuses on the initial coin offerings funding mechanism, which is based on a distributed ledger technology. The second paper, by Yermack (2017) is cited by 7 other papers and focuses on the benefits offered by blockchains in

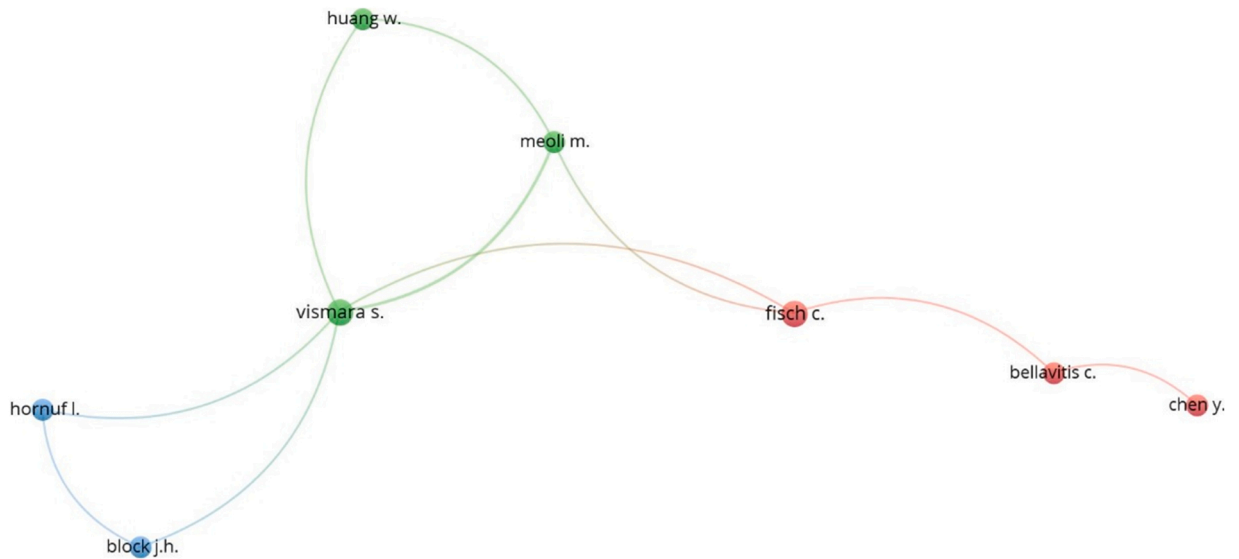


Fig. 2. The co-authorship analysis, The figure shows the co-authorship analysis. The minimum scale for the co-authorship analysis is 2 documents co-authored with minimum 20 citations.

Source: Author's calculation.

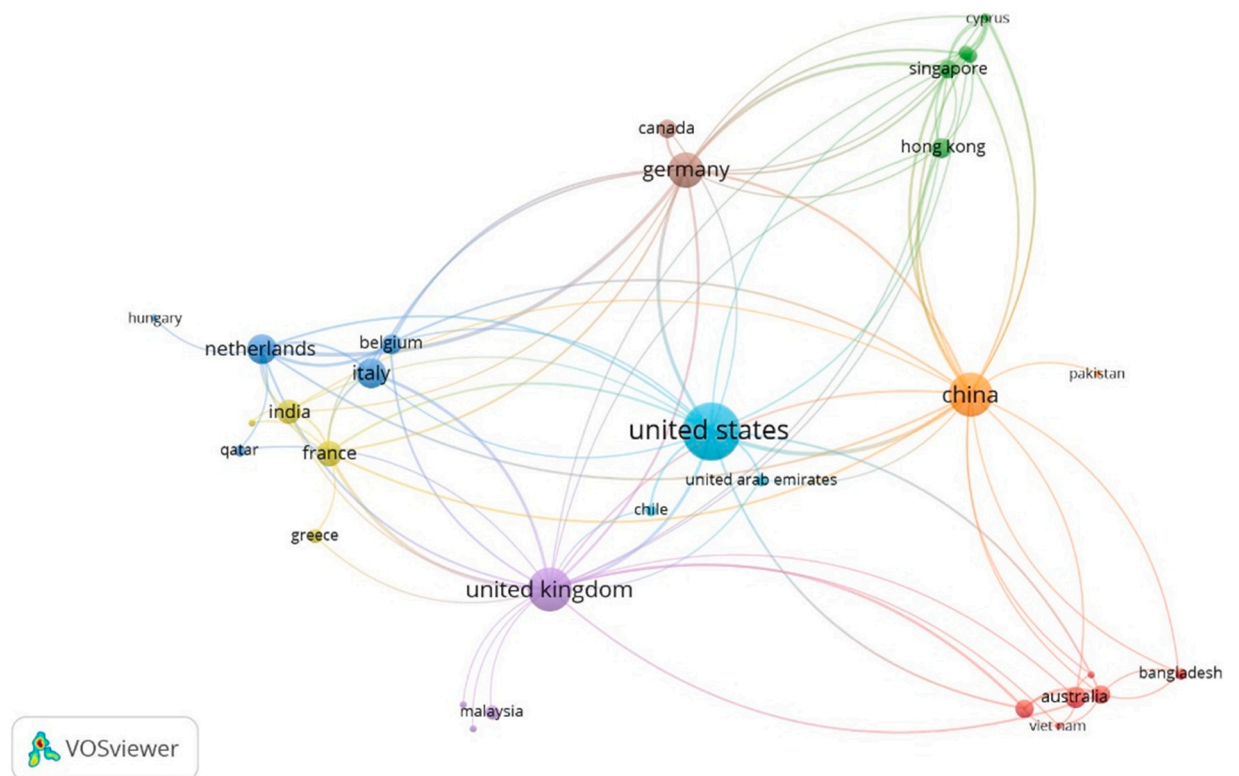


Fig. 3. The co-authorship analysis – Country, The figure shows the co-authorship analysis for the countries. The countries with minimum one co-authored documents are included.

Source: Author's calculation.

corporate governance. The paper by [Adhami et al.,\(2018\)](#) received 6 citations and deals with initial coin offerings and blockchain technology. The fourth paper in our list, [Vismara \(2018\)](#), focuses on information cascades among investors in equity crowdfunding. The paper by [Block et al., \(2018\)](#), fifth in the ranking, with 5 citations, focuses on the Technology-related factors in entrepreneurial

Table 7
Top keywords.

Rank	Key word	Occurrence
1	Blockchain	30
2	Initial Coin Offering	24
3	Blockchain Technology	21
4	Finance	20
5	Cryptocurrency	14
6	Impact	9
7	Evidence	8
8	Challenge	5
9	Blockchain Adoption	4
10	Cryptocurrency Market	4
11	Entrepreneurial Finance	4

The table shows the most frequently occurring keywords, with minimum occurrence of four times in ABS journals, between 2008 and 2021.

Source: Author's calculation.

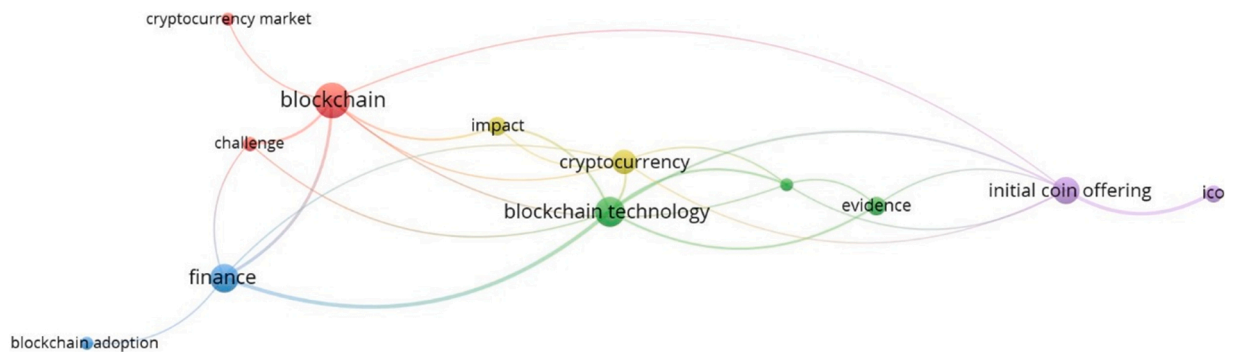


Fig. 4. Cartographic Analysis, Fig. 4 shows the cartographic analysis based on a minimum of four occurrences of a word among the papers in the sample.

Source: Author's calculation.

finance. Further, [Guo and Liang \(2016\)](#); [Risius and Spohrer \(2017\)](#); [Rossi and Vismara \(2018\)](#); [Corbet et al., \(2019\)](#) and [Katsiampa \(2017\)](#) provide significant contribution to the field of block chain technology in banking and finance, as well, and received 4 citations by peer-articles in our sample.

4.4. Influential institutions

[Table 9](#) shows the influential institutions based on (a) number of published papers and (b) number of citations. To be considered influential, institutes are supposed to have a minimum of 2 published papers in an ABS-ranked journal. In terms of the number of citations, we consider publication with more than 125 citations. As showed in [Table 9](#), the majority of the influential institutes are from North America and Europe, even though the most influential one by number of articles published is the University of Waikato in New Zealand. Considering both the number of paper published and the number of citations, the fifteen most influential institutions in the field are: Blockchain Research Lab, Cesifo, Max Planck Institute for Innovation and Competition, University of Hamburg, Trier University and Goethe University of Frankfurt in Germany, Dublin City University of Ireland, Delft University of Technology, Tilburg University and Erasmus University from Netherlands, University of Bath and University College London of United Kingdom, University of Antwerp from Belgium and Zhongnan University of Economics and Law, China, Pennsylvania State University, University of Delaware, the State University of New Jersey, Southwestern University of Finance and Economics & Cornell University of United States, Singapore Management University, Singapore. These results are coherent with the fact that the topic is mainly studied in North America and Europe, with a recent improvement in Asian and south-pacific countries. Finally, as the topic analysed is at the intersection between technology and finance, we examine the academic background of the scholars and realise that authors with very different backgrounds join forces when it comes to contribute to the blockchain in banking and finance literature. Within our sample, there are scholars from Accounting, Finance, Banks and other financial institutions, Blockchain research centre, Blockchain research lab, Business, economics, sustainability and inclusive development studies, law, industrial management, information engineering, business analytics, supply chain, information systems, financial economics, Mathematical sciences, and Management.

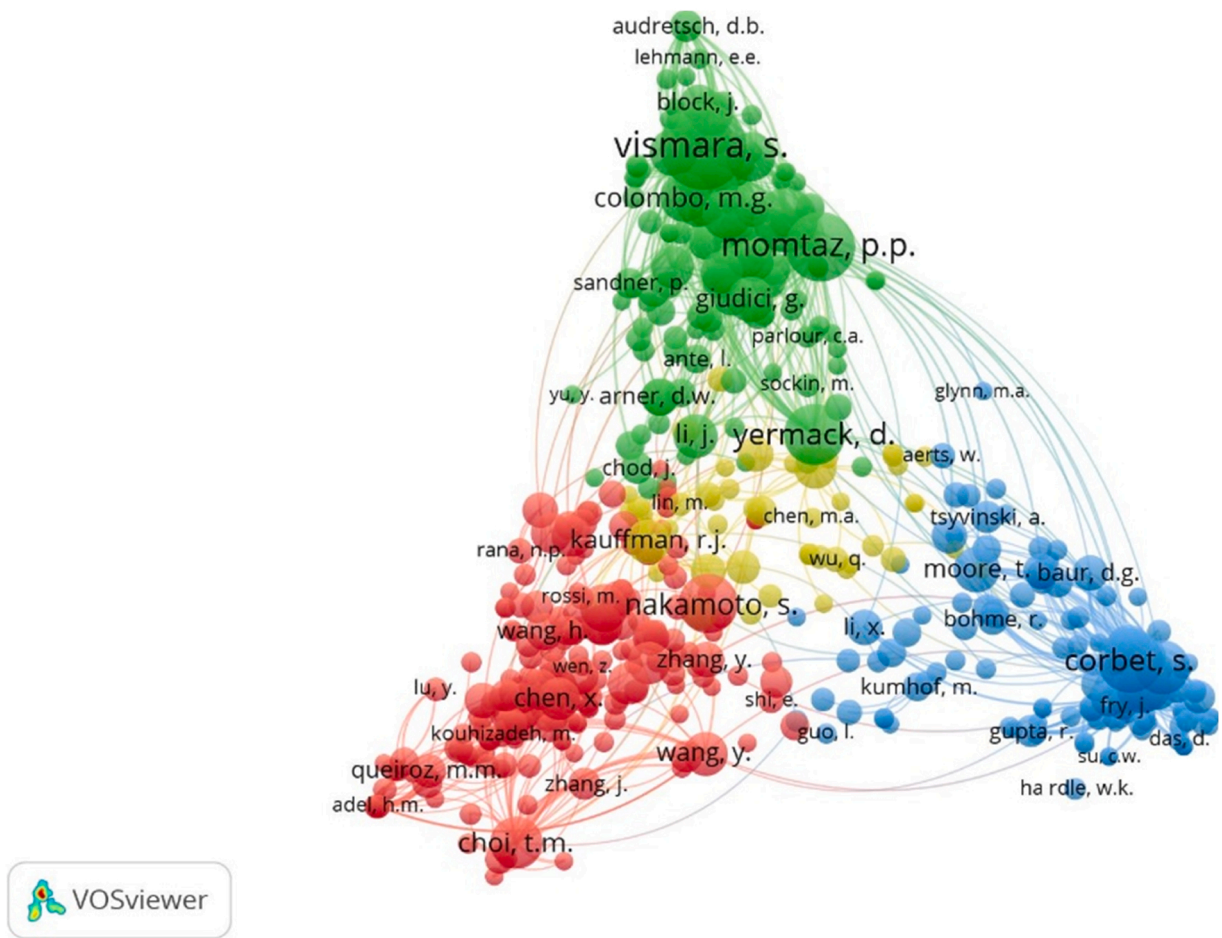


Fig. 5. Co-citation Analysis, Fig. 5 shows the co-citation analysis based on a minimum of 5 cross-citations among the papers in the sample. Source: Author’s calculation.

Table 8
Top ten co-cited references.

Rank	Cited reference	# documents citing paper
1	Fisch (2019)	8
2	Yermack (2017)	7
3	Adhami et al., (2018)	6
4	Vismara (2018)	6
5	Block et al., (2018)	5
6	Guo and Liang (2016)	5
7	Risius and Spohrer (2017)	5
8	Rossi and Vismara (2018)	4
9	Corbet et al., (2019)	4
10	Katsiampa (2017)	4

The table shows the top co-cited references on blockchain technology in banking and finance. References are considered as per the number of documents cited a paper over the period 2008–2021. The references with minimum 4 document citations are considered in the ranking.

Source: Author’s calculation.

4.5. Bibliographic coupling analysis

Fig. 6 shows the bibliographic coupling of the articles in our sample, with different clusters, in different colours. The bibliographic coupling analysis map is based on the number of citations an article received within the sample, as well as the strength of the link. In a bibliographic coupling analysis map, the size of the nodes reveals the total link strength between articles. The coupling of bibliographic

Table 9
Top organizations.

Documents		
R.	Organization	# documents
1	University of Waikato, New Zealand	3
2	Blockchain Research Lab, Germany	2
3	Cesifo, Germany	2
4	Dublin City University, Ireland	2
5	Delft University of Technology, Netherlands	2
6	University of Bath, United Kingdom	2
7	Max Planck Institute for Innovation and Competition, Germany	2
8	Zhongnan University of Economics and Law, China	2
9	Tilburg University, Netherlands	2
10	University of Antwerp, Belgium	2
11	University of Hamburg, Germany	2
Citations		
R.	Organization	# citations
1	Goethe University of Frankfurt, Germany	227
2	Pennsylvania State University, United States	227
3	University of Delaware, United States	227
4	Singapore Management University, Singapore	227
5	The State University of New Jersey, United States	196
6	Southwestern University of Finance and Economics, United States	196
7	University College London, United Kingdom	162
8	Erasmus University, Netherlands	147
9	Trier University, Germany	147
10	Cornell University, United States	127

Table shows the top organizations as per the documents and citations.
Source: Author's calculation.

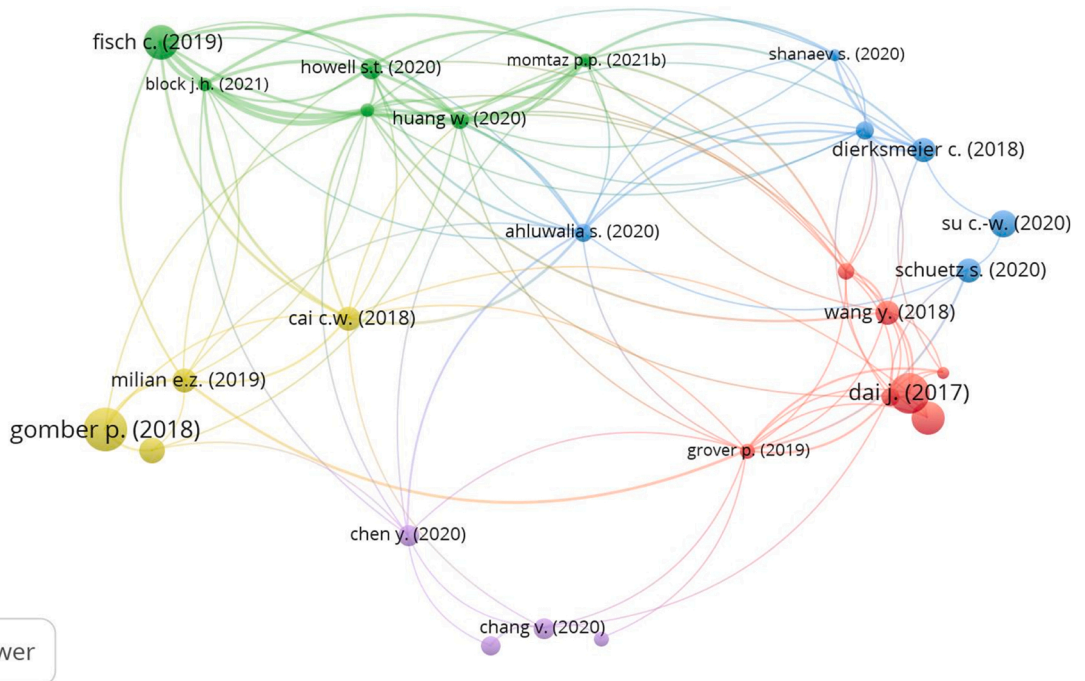


Fig. 6. Bibliographic coupling analysis map, Fig. 6 shows the articles with a minimum total link strength of 125, as determined by the bibliographic coupling analysis.
Source: Author's calculation.

nodes shows the distance, or closeness, of the studies in the network. Moreover, sharing a significant number of references reflects closeness between articles (Marchiori and Franco, 2020). Table 10 shows the bibliographic coupling analysis of the top five cited articles based on the total link strength. Only articles with minimum 125 link strength are considered. The strength of an article shows

its connections to other papers within the sample. As reported in Table 10, Flori (2019) has the highest total link strength in the sample. The paper gives a comprehensive review on Bitcoin. The study by Hackober and Bock (2021), with the second highest total link strength, provides evidence that the presence of venture capital investors has a positive impact on blockchain-based ventures' success in the mid-term. Hu et al. (2021) examine whether corporate blockchain patent-developments influence Bitcoin volatility and shows that the corporate blockchain developments have a significant spillover effect. The study also suggests to examine the inherent risks with respect to blockchain and cryptocurrencies patent development. Momtaz (2021) examines Initial Coin Offerings with respect to the moral hazard risks in an entrepreneurial finance context. Similarly, Block et al. (2021) compare crowdfunding and initial coin offerings, which may appear similar funding mechanisms, but have many differences, which matters for different stakeholders.

5. Review of the research streams

We conducted a detailed content analysis of the 154 articles included in our sample to better explore the different areas that constitute the literature on Blockchain in Banking and Finance. The content analysis shows four main research streams highly interdependent; such repartition has been confirmed by the co-citation analysis (see Fig. 5), which we performed as a robustness check. The first research stream, "Impact on financial intermediation", includes the contributions dealing with the structural, strategic, operational, and organisational changes that the blockchain technology has directly or indirectly caused among incumbents. This research stream appears at the left bottom corner of the Co-citation graph in Fig. 5, in colour red. The second research stream gathers all the main "Financial Applications" of the distributed ledger technology within the financial system. This stream comprises the majority of the contributions to the literature and can be further split into thematic sub-streams, as shown in paragraph 5.2. In the co-citation analysis, this stream is identifiable by the colour green (see Fig. 5). The third research area identified focuses on "Regulation and Cybersecurity", a sensitive topic, still open to debate, which gathers contributions from both authors that maintain the need for a strong regulation because of the potential opacity of distributed ledger technologies and an opposite stream, which highlights the benefits of blockchain technology applications in terms of security, transparency, and accountability. This stream is identifiable by the colour blue at the right bottom corner of the Co-citation analysis reported in Fig. 5. In the middle of the Co-citation graphs there is a yellow area, highly connected with all the aforementioned streams; this area represents the contribution to the emerging "Sustainable Blockchain" sub-stream, further discussed in Section 5.4.

5.1. Impact on financial Intermediation

Traditionally, the financial system relies on a number of centralized intermediaries, FinTech solutions, based on distributed ledger technologies, provide a disruptive alternative to the way the whole system has been organised so far. In particular, supply chain finance coupled with blockchain technology bypasses the need for central financial intermediaries, lowering transaction costs and improving business efficiency. Meanwhile, the trust in traditional intermediaries has been increasingly questioned, due to financial scandals, crises, and arguable cybersecurity; in this context, decentralized systems like blockchain that reduces the need for intermediaries has found fertile ground. Hence, blockchain applications have become prominent in global financial markets, and have played an important role in the banking industry, as well, in the last decade and especially in recent years. An insightful Chinese case-study (Hua and Huang, 2021) identifies three key drivers for blockchain adoption, which may partially apply to other economies, too, namely the lack of availability of formal financial market, a strong government support for promoting financial inclusion through digital technology, and a mild regulatory environment. In the early days, blockchain diffusion was mainly perceived as a potential threat to the banking industry, because, as any distributed ledger technology, blockchain significantly increased the competition degree, due to non-bank institutions providing competing services in a quicker, cost-efficient way, closer to the changing customers preferences (An and Rau, 2021). Moreover, blockchain technology can provide semi-formal financial services that target financially excluded or unbanked individuals (Larios-Hernández, 2017). Coherently, within the extant literature, scholars highlight the need for traditional intermediaries to adjust to the trend of digital transformation, as their market share may be threatened by non-banks (e.g., Harris and Wonglimpiyarat, 2019). Moreover, the trust element inherent in blockchain financial applications enables this technology to substitute for intermediaries, but more recent studies show that this is still not the case for all financial areas (e.g., Cai, 2018). Most centralised financial intermediaries, in any case, quickly realised the potential benefits of adopting such a rampant technology, instead of trying to stand up to it. Interestingly, this "flight to blockchain" has further increased the level of competition within the banking industry, because "most banks still compete to create their own Blockchain banking systems" (Harris and Wonglimpiyarat, 2019).

On the face of it, the transition towards a more technological and digitalised banking system hasn't been neither quick nor smooth for financial intermediaries and it is still an on-going process. Among the new technologies that the Fourth Industrial Revolution brought about, blockchain is the most akin to the business of banking, therefore it has proved to be the most impactful and promising one, so far. As a consequence, a growing number of scholars focuses their attention on the impact of the advent of blockchain on the strategy, operations, and organisation of financial intermediaries; most of these contributions highlights the positive aspects of such advance with a few exceptions, as further discussed. Larios-Hernández (2017) and Harris and Wonglimpiyarat (2019), for instance, focus on the strategic and logistical changes that traditional financial intermediaries may face due to blockchain technology adoption; they underline how such technology has the potential to make redundant the intermediary role of banks and the centrality of physical counters in banks' strategy, as money transfers may not need a centralised payment network any longer. The blockchain platform becomes a virtual intermediary, lowering infrastructure costs and overheads together with transaction costs (e.g., Kimani et al., 2020). In this way, the transfer of digital financial flows in the form of peer-to-peer, business-to-business, business-to-consumer, or consumer-to-consumer lending may become quicker, cheaper, and safer. The pressing digital revolution has been pushing the banking

Table 10
Bibliographic coupling analysis.

Rank	Document	Total link strength
1	Flori (2019)	203
2	Hackober and Bock (2021)	173
3	Hu et al.,(2021)	151
4	Momtaz (2021)	138
5	Block et al., (2021)	125

This table shows the bibliographic coupling analysis as per the total link strength. Articles with minimum total link strength of 125 are considered as top articles as per the bibliographic coupling analysis. Source: Author's calculation.

system towards heavy investments in information technology (IT), in an attempt to improve the efficiency and security of the financial innovations adopted, from Automated Teller Machine (ATM), electronic fund transfer and phone banking to internet banking, mobile banking, cryptocurrency wallets and the so called Blockchain banking. The Blockchain banking development seems to be similar to other major financial innovations in the past history, as it requires extensive investments in software and hardware specific to the innovation and interoperability among third parties, together with a tight cross-industry cooperation ([Harris and Wonglimpiyarat, 2019](#)). From a strategic perspective, banks have pursued collaborative partnerships and collaborations across industries, which serve both the investment sharing purpose and their competitive nature. Despite the sizable initial investments and the continuous process to update banks' IT, scholars (e.g., [Do et al., 2020](#)) provide evidence of the positive effect that the introduction of the blockchain technology has in terms of cost efficiency. For instance, [Cucculelli and Recanatini \(2021\)](#) provide evidence of sizable savings, particularly evident in post-trading processes, moreover, distributed ledger technologies are acting as catalyst for innovation in the banking industry, as further discussed in paragraph 5.2 (e.g., [Cucari et al., 2021](#)). Blockchain technology has broadened the array of both retail and commercial financial services that a bank can provide but it has been particularly exploited to provide more complex services with high added value ([Gomber, 2018](#); [Wang et al., 2021](#)). Consequently, blockchain banking has further increased the relative importance of service fees and commissions as a source of revenues for banks. Another significant change due to blockchain adoption involves banks' business models, one of the most recent examples are smart contracts and their impact on value chains, hierarchies and processes ([Rajnak and Puschmann, 2021](#)). Some valuable contributions (e.g., [Chong et al., 2018](#); [Krainer, 2017](#)) further investigate the impact of new technology-enabled value chains and develop frameworks on how incumbent banks may accelerate favourable blockchain innovations. For instance, [Rajnak and Puschmann \(2021\)](#) provide evidence that high IT innovation is connected with changes in banks "operational excellence", meaning affordability, accuracy and availability of their supply, "customer intimacy" (i.e., service quality and customer satisfaction) and "product leadership", leading to deep adjustment from an operational and strategic point of view. Interestingly, [Dicunzo et al. \(2021\)](#), highlight the importance of guiding the managerial culture towards new technologies before implementing the strategical and organisational changes to adopt distributed ledger technologies. Similarly, other authors (e.g., [Cucari et al., 2021](#); [Saheb and Mamaghani, 2021](#)), show that among the most critical barriers to extracting value from blockchain there is the lack of understanding by banks' top managers, followed by organizational and environmental obstacles, regulatory requirements, and marketing noise. Lastly and surprisingly in a certain way, the adoption of blockchain by banks seems to exert a positive influence on their riskiness and stability (e.g., [Cucari et al., 2021](#); [Papadimitriou et al., 2020](#)), even though some case studies (e.g., [Cheng and Qu, 2020](#)) provide mixed evidence in this regard. On the other hand, [Sun et al. \(2021\)](#) construct an evolutionary game model, according to which blockchain technology can reduce the credit and operational risk of financial institutions and improve their business income; some studies (e.g., [Papadimitriou et al., 2020](#)) bring it even further suggesting benefits in terms of intermediaries' transparency, financial prudence and stability or organisational culture and competitiveness ([Cucari et al., 2021](#)). Overall, the benefits of blockchain seem to overweight its drawbacks (e.g., [Ahluwalia et al., 2020](#); [Gan et al., 2021](#)) and [Rijanto \(2021\)](#) shows that the drivers of blockchain adoption in banking are its validity and the perceived usefulness of distributed ledger transaction data. This evidence seems to be backed by the development of blockchain banking trend, which is positive and increasing since 2008 ([Cheng and Qu, 2020](#)).

Nonetheless, there is widespread awareness of the limits and potential threats of blockchain adoption in banking and this is reflected in the academic literature, as well (e.g., [Dashottar and Srivastava, 2021](#)). For instance, [Chang et al. \(2020\)](#) highlights the main challenges posed by blockchain applications, which are scalability, security, energy consumption and privacy leakage, according to the authors. This last problem has been reported by [Du et al. \(2020\)](#), as well, who propose a new method of using homomorphic encryption in the blockchain to meet the needs of sensitive data privacy protection in supply chain finance. Finally, some authors hinder the adoption of blockchain on a large scale, as the contributions in utilising blockchain in the banking and financial sectors appears to be limited when compared to other industries (e.g. [Erol et al., 2020](#)).

5.2. Financial applications

The areas of potential application of blockchain in finance are numerous and heterogeneous — mainstream payment, clearing and settlement, securities issuance, trade repositories, venture capital, insurance, real estate, advisory and many others. Most of these domains are already technologically developed, and the challenges are primarily reputational, legal, institutional, and ethical. The paragraph below summarises in brief the main findings in the extant literature.

5.2.1. Cryptocurrencies

From 2008 onwards, cryptocurrencies have become a focal point for financial practitioner, policymakers and scholars as a disruptive innovation in financial markets and the kick-off of the Fourth Industrial Revolution; almost 12% of the sample consists of papers directly focused on cryptocurrencies. Cryptocurrencies, though catalysed a multidisciplinary attention including scholars from technical fields, economics, law, public economics, accounting, and other disciplines (Holub and Johnson, 2018; Petukhina et al., 2021). Along with the growing popularity, the market capitalization of cryptocurrencies has been increasing substantially currently exceeding \$1.3 trillion.² Cryptocurrencies have been categorised as a stand-alone asset class characterised by particularly long tails of the returns, striking volatility and low values of the α -stable tail parameter, indicating large departure from normality (Pele et al., 2021). Overall, the inclusion of this asset class in a diversified portfolio seems to be beneficial to its risk-return profile (Petukhina et al., 2021), but such benefit is tempered by a high degree of illiquidity; therefore, their net effect very much depends on investors' characteristics. Within the literature, Bitcoin has a privileged position, as Satoshi Nakamoto's digital coin has been the frontrunner of cryptocurrencies. Nowadays though, despite being a very heterogeneous asset class, the extant literature provides empirical evidence of a synchronic evolution of cryptocurrencies, that tend to converge towards a common set of characteristics over time (Pele et al., 2021). Cryptocurrencies are characterised by the presence of a blockchain as a core component, and of a peer-to-peer network that transfers value between participants, together with a proof-of-stake as a validation mechanism (Cai, 2018). Another characteristic often cited is the trust they obtain from the users, even though this aspect is controversial within the literature. On the one hand, some scholars claim that the lack of trust in the traditional financial system has been one of the main factors that allowed cryptocurrencies to thrive. According to Malherbe et al. (2019), for instance, cryptocurrencies benefit from a "methodical trust" thanks to an objective proof of payment mechanism, a "hierarchical trust" due to the mining process, and an "ethical trust", apparently because of cryptocurrencies' complete disintermediation, even though cryptocurrencies' ethical commitment is questionable. On the other hand, another stream of literature takes a more cautious stance towards cryptocurrency adoption. For instance, Beigman et al. (2021) argue that it is difficult to assess their fair value, because the economic fundamentals underlying their pricing are yet to be fully comprehended and the traditional inference based on normal distribution seems to be inappropriate, due to their high exposure to tail risks (Pele et al., 2021). Moreover, due to the heterogeneity and continuous evolution of the traded cryptocurrencies - the total number of cryptocurrencies is 7812³ - and the dispersion of the trading venues, a principal market may be difficult to identify (Beigman et al., 2021). Furthermore, some scholars (e.g., Ciriello, 2021) highlight how cryptocurrencies extreme volatility on the one hand prevents them from being used as traditional currency, and on the other, leaves this asset class as the prerogative of short-term speculators, rather than long-term investors. Finally, their price volatility is particularly sensitive to public statements via social media both on the part of supporters and detractors, among the latter there are distinguished economists such as Joseph Stiglitz and Paul Krugman, who condemn them as bubbles or even elaborated Ponzi scheme, and environmental threats.

5.2.2. Tokens and Tokenisation of fiat money

Tokens are units of value issued by an organisation built on an existing blockchain, using smart contracts. Tokens are recognised as a stand-alone asset class, whose evaluation discount blockchain specific risk factors, among the traditional financial parameters (Nadler and Guo, 2020). As a matter of fact, tokens and tokenised securities peg their value to an underlying asset, which could be cryptocurrencies, real estate, commodities, or fiat money. Technically there are three main ways in which ordinary fiat money can be converted into tokens on a blockchain; the first one requires sovereign countries or central banks to directly issue digital money on a blockchain (e.g., Malherbe et al., 2019). For instance, Marthinsen and Gordon (2020) have designed a customized token for nations suffering from hyperinflation and this model can be adjusted to accommodate virtually any transition to a more stable monetary environment. Cukierman (2020) maintains that given the fast development of private digital currencies, central banks will eventually be bound to issue their own digital currencies; the author designs two models to transition towards central banks tokens, a transitional one in which only the banking sector has access to deposits by the central banks and a more radical one that completely disintermediates financial intermediaries. Despite the premises being promising, concerns about accountability, legal boundaries, technical challenges and fears for the stability of financial intermediaries are slowing down most central banks' decision to issue tokens or cryptocurrencies (Savona, 2021). The second method is for a large, trusted institution to issue a cryptocurrency fully convertible into fiat money, this methodology despite being technically possible presents both legal obstacles and issues in terms of collateral required to stabilise its value. Finally, decentralized smart contracts can be used to create a token that is pegged to a fiat currency (i.e., Stablecoins); in this case, further studies are needed to shed light on the effect of stablecoins issuance on the fiat money they are pegged to. Ante et al. (2021) analyse the market behaviour of seven cryptocurrencies around the related stablecoin issuances and find market downturns in the week before issuance and positive abnormal returns in the twenty-four hours around the issuance; it would be interesting to understand whether stablecoin issuances contribute to price discovery and market efficiency of sovereign currencies, as well.⁴ The principle underlying stablecoins can be adapted to create any kind of tokenized securities (e.g., tokenised stocks, real estate, index funds, etc), which should enable price stability, programmability, pseudonymity, and transaction efficiency (Ciriello, 2021), while also introducing new regulatory challenges and market uncertainties.

² <https://coinmarketcap.com> as of May, 13th 2022

³ coinmarketcap.com, as of January, 20th 2021

⁴ At the moment, only tokenised US Dollars (Tether) may be the subject of such analyses.

5.2.3. Crowdfunding and venture capital

Initial Coin Offerings (ICOs) are one of the most influential innovations that characterize the digital revolution of financial markets. They consist of a new method of raising capital by issuing digital tokens for early-stage ventures, so they can be defined as an alternative to more traditional funding sources for start-ups (e.g., business angels, venture capital, private equity or crowdfunding) based on a blockchain (Fisch et al., 2020; Levasseur et al., 2021). The use of tokens, the publication of a white paper and the fact that they are decentralised are the core characteristics that distinguish ICOs from more traditional financing techniques. The numerous studies that focus on ICOs' critical success factors (e.g., Belitski and Boreiko, 2021; Campino et al., 2021; Cheng and Cheng, 2020; Fisch et al., 2020; Howell et al., 2020; Sharma and Zhu, 2020; Schückes and Gutmann, 2021; Zhang et al., 2021a, 2021b) mainly agree on the whitepaper quality to be an effective marketing tool that positively influences investor perception and investor trading behaviour, and that the size of the ICO, the presence of bonus schemes, the entrepreneur's education and social identity, the operation and advisory team numerosity, positively influence ICOs success. Interestingly, even social media coverage and comments frequently emerge as an important tool to build trust in ICOs. Finally, the presence of a start bonus and being financed by a venture capital fund are significantly related to the success of ICO offering, the offer price, and post-ICO performance. Unsurprisingly, the literature shows that ICOs take place more frequently in countries with developed financial systems, public equity markets, and advanced digital technologies (Huang et al., 2020). ICOs have had great success – in 2019 alone, more than \$ 3,3 billion USD have been raised in ICOs (Haffke and Fromberger, 2020) – because of the anonymity they ensure and because they are perceived as bringing more equality to the access to financial resources by categories usually underrepresented among potential borrowers. For instance, Fisch et al. (2020) show significant participation and likelihood of successful campaigns for ethnical minorities in ICOs. Female entrepreneurs, however, do not have higher chances to participate nor raise funds in ICOs, compared to more traditional funding sources. In any case, ICOs are not devoid of weak points, as some authors point out (e.g., Y. Chen and Y. Chen, 2020; R.R. Chen and R.R. Chen, 2020). Firstly, ICOs present serious information asymmetries, that detailed whitepapers only partially attenuate, moreover Q. Gan et al. (2021); J. Gan et al. (2021) show that without an ad-hoc regulation, ICOs can lead to significant agency costs, underproduction, and even loss of firm value, even though these inefficiencies are less severe under equity token issuances. To conclude, Hornuf et al. (2021), focus their research on the different types of fraud, affecting ICOs and provide evidence that on average the fraudulent ICOs are significantly larger and that issuers who disclose their code on the whitepaper are more likely to be targeted by phishing and hackers. These findings support the need for specialised platforms that certifies and rates the quality of ICOs', especially for those issuances that are not backed by institutional investors and venture capital funds that can perform a proper due diligence.

5.2.4. Financial services

Blockchain technology can be applied to virtually any service provided by financial intermediaries, to increase their usability. Guerar et al. (2020) analyse the application of blockchain technology to invoice financing, a steadily growing component of the financing market where the risk of frauds is still very high. They propose an invoice financing platform based on a public blockchain supporting both fully open and group-restricted auctioning of invoices, which ensures data confidentiality, transparency and trustworthiness thanks to a reputation system based on the past behaviour of users. A separate stream of literature maintains that peer-to-peer (P2P) lending platforms may benefit from the adoption of blockchain technology, as well; Gonzalez (2020) provides evidence of the beneficial effect of blockchain application to assist in predicting non-performing loans and monitoring bad loan recovery thanks to a trust-enhancing heuristics detector, which compounds the data available in the platform. Among the numerous areas of applications, clearing and settlement has been recently the focus of attention, because of the potential for improvement given by blockchain adoption. The blockchain has the potential to provide new ways of transferring and recording the ownership of digital assets, immutably and securely storing information, providing for identity management. Therefore, settlement of securities and post-trade clearing may largely benefit from distributed ledger technologies' properties and overcome the operational weak points of the existing services. Mills et al. (2017), though warns about the challenges around the development of such nascent technology, for instance risk management and legal hurdles. Finally, this technologically advanced application needs to be fully understood and mastered by the financial practitioners practically involved in clearing and settlement operations and this may cause some delay in its adoption. Similarly, Guo and Liang (2016) propose that payment-clearing systems (PCS) may serve as appropriate scenarios of blockchain application, as the blockchain technology provides decentralization, full replicability and inbuilt cryptography and such properties may contribute to alleviating issues such the lack of mutual trust, high transaction costs and fraud that are sometimes associated with PCS. Likewise, banks' credit information systems may benefit from the same advantages provided by the blockchain technology that can become a substitute for trust in central intermediaries. To conclude this overview of the studies that focus on practical applications of the blockchain technology to financial services, we consider the real estate sector. The related literature (i.e., Wouda and Opendakker, 2019; Saull et al., 2020; Worzala et al., 2020) points out that once again blockchain technology adoption may improve the perception of opacity that permeates the sector. For instance, the lack of structured and quality data on the characteristics of a property may be solved by the application of a blockchain that compiles physical, legal, and contractual information. This could alleviate the information asymmetry between buyers and sellers, avoid the need for lengthy and costly due diligence and consequently reduce the delays and transaction costs in real estate trades. Moreover, according to the literature, an up-to-date, single platform that gathers standardized information on properties built on a blockchain may be more efficient and trustworthy compared to some previous solutions, such as property passports (Saull et al., 2020). Of course, the roadmap to transform real estate operating companies into high-tech enterprises, would take time and technological investments together with a change in their organizational structure, know-how and methods of sale.

5.2.5. Insurance

InsurTech identifies the use of technology innovations applied to the traditional insurance business model. The peculiarity of the application of distributed ledger technology to the insurance sectors, compared to other financial application, is that InsurTech not only provides technological solutions to overcome some structural limitations of the industry, but it also introduces new products, for instance, ultra-customised policies or dynamics price premia mechanisms that adjust according to the client behaviour. Moreover, blockchain-based Insurtech solutions may improve current auditing practices, resulting in a more precise, timely and automatic assurance system (Dai and Vasarhelyi, 2017). Compared to overall FinTech, InsurTech is still at an early stage; some authors (e.g., Cao et al., 2020) identify the most effective levers to boost its growth in public media coverage, overall technological development of the host country and regulation. To further encourage InsurTech adoption, some authors (e.g., Sheth and Subramanian, 2019) model blockchain-based smart contracts prototypes, specifically for the insurance industry operating on a decentralized insurance marketplace. In particular, three contracts based on Ethereum-blockchain, backed by demand-supply equilibrium, and principal-agent theory designed using constrained-optimisation, seem particularly promising. The authors illustrate how such smart-contracts increase social welfare by shifting demand and supply and reducing transactional costs.

5.3. Cybersecurity and regulation

The third research stream identified within the literature regards cybersecurity and blockchain regulation. A substantial stream of literature focuses on this aspect, because so far it has been the most challenging obstacle to widespread blockchain diffusion. Blockchain technology has been designed to be anonymous and this core characteristic leaves room to potential misuse in the so-called dark web. Differently, the possibility to protect users' identity could be legitimate and useful if addressed to protect users' privacy, for instance using homomorphic encryption in the blockchain to meet the needs of sensitive data privacy protection in supply chain finance (Du et al., 2022). As a matter of fact, blockchain may be a potential solution to the problem of cybersecurity in financial transactions and blockchain technology is so ductile that organisations may be able to model their own strategic and fundamental objectives for evaluating cybersecurity via blockchain-based solutions aimed at improving the financial security of financial transactions (Mishra and Kaushik, 2021; Smith and Dhillon, 2019). In spite of this, even within the legitimate applications of blockchain, the anonymity of the exchanges may leave room to illegitimate behaviours. For instance, Le Pennec et al. (2021) report that cryptocurrency exchanges allegedly use wash trading to falsely signal their liquidity. They also provide evidence that exchanges that engaged in wash trading exaggerate their true volume by a factor of 25–50. Similarly, Benedetti and Nikbakht (2021) find abnormal significant increases in price, trading volume, network growth and on-chain activity around the date of a token's first cross-listing. Another core characteristic of blockchains is the decentralisation, therefore there is no designated authority to act as regulator or supervisor. In this regard, blockchain policy uncertainty has been detrimental to its reputation. Yang and Li (2018) recognise the existence of a "pacing problem" between distributed ledger technology innovation and regulation, with the former developing way faster than the latter. Moreover, given the peculiarity of blockchain technology, they suggest that only a technology-driven regulation, specifically focused on cyber and data monitoring may protect financial consumers' rights and interests, whereas traditional financial regulation could hardly be effective in this regard. These considerations are backed by other contributions (e.g., Yang and Li, 2018; Hua and Huang, 2021; O'Dair and Owen, 2019) that highlight the importance of an ad-hoc regulation with innovative policy tools to monitor and regulate the new financial risks that blockchain technology application in banking and finance entails, while providing room for the inevitable innovation and development of this booming sector. Some niche contributions (e.g., Sargent, 2021), finally point out the complexity and peculiarities of Blockchain verification in auditing context. The uncertainty around blockchain technology due to the lack of a formal regulation, is also causing some sort of "blockchain washing", that is the release of announcement related to fake blockchain development. For instance, Cioroianu et al. (2021), provide evidence that speculatively-driven announcements related to blockchain-development, from reactionary-driven companies with no prior technological development experience, generate abnormal pricing performance of approximately 35%, when compared to strategically-denoted projects. To prevent such misconducts, decentralized ledgers should make information accessible to regulatory and supervisory authorities. In this context, investors' education coupled with ad-hoc regulatory enforcement appear to be a promising solution to reduce financial misconduct in the digital marketplace (Savona, 2021; Shanaev et al., 2020).

5.4. Blockchain and sustainability

Sustainable blockchain applications is the literature sub-stream most connected with the other three sub-streams, and notably with the studies regarding the impact of blockchain on banking sector and blockchain financial applications; this high interdependence with the other streams is confirmed by the central position of sustainable fintech contributions in the co-citation graph (see Fig. 5). As it is well known, sustainability entails both environmental and social aspects, together with attention to corporate governance. This multidimensional nature is reflected in the contributions on sustainable fintech. A sub-stream of articles revolves around the benefits and the threats that blockchain applications may reflect on the environment, whereas some other authors focus on the possible social impact of such innovations. The critical analysis of literature indicates a growing concern for the negative impact that blockchain financial applications, and in particular crypto mining, have on the environment. Actually, mining cryptocurrencies requires enormous amounts of energy and a number of scholars (e.g., Mohsin et al., 2020; Polemis and Tsionas, 2021) provide empirical findings that corroborate a causal effect between the use of cryptocurrencies, Bitcoins in particular, and carbon dioxide emissions generated by the increasing energy load necessary to mine them. This stream of research highlights a close link between miners' revenues and emissions, suggesting that a sustainable energy strategy that includes the use of renewable energy sources and energy-efficient mining hardware

Table 11
Future research agenda.

Impact on Financial Intermediation (Cai, 2018)	More cross-disciplinary studies utilising technology, economics and psychology are required to examine blockchain-based crowdfunding
(Larios-Hernández, 2017)	To what extent would the bottom-up, self-organized approach find itself in the position to drive business success? How can semi-formal services be facilitated by blockchain and mobile digital platforms? Would people approve their inclusion in this type of service? How would these services merge with the existing formal offering? How can regulation be updated to support semi-formal services?
(Cucculelli and Recantini, 2021)	Future research on DLT systems could focus on the technical, legal, and other industry-specific aspects, for instance, in performing case studies of DLT systems, the framework could be the first step towards more case- and industry-related technical developments. Additionally, regulatory and legislative research could be conducted in relation to this framework.
(An and Rau, 2021)	how blockchain development will change the optimal size of financial firms? financial technology increases (or decreases) firm size, what are the mechanisms? Does it slow the speed of diminishing return to management? Or does it reduce the coordination costs at all levels?
(Hua and Huang, 2021)	The paper calls for research on how to provide primary solutions to the problems inherent in the China's fintech market, such as misuse of private information, financial fraud crimes, money laundering, and so on. Second, there seems to be a lack of research on the most recent evolution of regtech and how it interacts with as well as reshapes China's fintech market. Third, whether regionally diversified cultures and informal institutions play a significant role in adoption of fintech in different parts of China is also a novel research area to explore. Fourth, how the emerging global digital currencies such as Libra compete with state-issued fiat or digital currencies in China?
(Rajnak and Puschmann, 2021)	How will banks adapt to these new emerging business models? A more in-depth perspective on geographical and country specifics might lead to interesting findings.
(Adel and Younis, 2021)	Are there other variables that can explain further positive drivers/outcomes of using Blockchain technologies (BCT) at individual, organisational and supply-chain levels? What is the impact of using BCT within supply chain finance on the development of other relevant corporate strategies (e.g., related to technology-enabled growth or retrenchment strategies)? this research question can be investigated in other countries/sectors using longitudinal data.
(Dcuonzo et al., 2021) (Osmani et al., 2020)	To what extent new technologies can help in overcoming the difficulties that emerge from the pandemic? More case studies or a large-scale survey study from multiple data sources will be helpful to understand the impact of these emerging technology solutions on supply chain finance (SCF). Furthermore, it is interesting to design and develop customized data mining and visualization approaches to analyse SCF when more IoT data becomes available. Which are the regulation issues of managing SCF on blockchain in the future?
(Gomber et al., 2018)	What will be the aggregate value of the fintech sector's contribution to financial services GDP? What will be the drivers for success among fintech start-ups, as the market becomes more crowded and the "low-hanging fruits" of technology innovation are harvested in industry? Will knowledge from the development and marketing of fintech innovation-based products and services spill over into other areas of business involving technology? Will the fintech sector be characterized by centripetal forces that lead to its agglomeration (market linkages, local knowledge externalities, thick labour markets, and national regulations)? Or will we instead observe the domination of centrifugal forces, leading to the globalization of the industry with punctuated equilibria of local innovations that are spun off for increasingly international R&D-driven service transformation? What theoretical basis is appropriate to apply or develop to understand the geographical locations of the core fintech innovations?
(Naimi-Sadigh et al., 2021) (Rijanto, 2021)	What is the impact of blockchain innovation on infrastructure, development, and business in the banking sector? What is the role of financial institution partners to the successful implementation of the blockchain in SCF? Can the advantages of blockchain technology spill over to the supply chain business community?
(Zhang et al., 2020)	We will need to explore the application environment of blockchain finance and economics from the perspectives of technology, applicability, regulation, and supervision to serve the whole society better.
(Garg et al., 2021)	Future studies may consider whether the case study has robust claims by testing the instrument in multiple countries
(Kowalski et al., 2021)	Future research on the role of technology enhancing trust relationship in trade finance may include different trading parties from diverse backgrounds. Furthermore, it is also crucial for future research to focus on a specific type of blockchain-based solution (e.g., smart contract or fraud detection) and its corresponding business model (e.g., subscription vs. transaction fee models) to understand its adaptability and relevance.
(Cucari et al., 2021)	Does blockchain solutions applied in banks modify the organisational culture/ foster competition strategies/ enhance competitiveness and performance within an ambidexterity strategy/improve the information processing/reduce operational risks?
Authors	Future research may focus on finding shared measures of fintech development in the banking sector Are operational risk measures enough to capture the riskiness brought to these disruptive innovations to the banking sector?
Financial Applications	
(Y. Chen and Y. Chen (2020); R.R. Chen and R. R. Chen (2020)	Further investigation on the informational factors on the success of ICO market is necessary. For example, the role of social media, types of platforms, characteristics of users, and communication channels should be further investigated in ICO issuing and value of post-ICO trading. In addition, how investor behaviours are influenced by different information contents also needs to be explored. Exploratory studies through interviews should be performed across different markets to build a preliminary and in-depth. It will be interesting to explore the role of characteristics of entrepreneurial founder teams in the success of ICOs, such as their past experiences and team culture.
(Chen, 2019)	Further research on the pricing mechanism in ICOs is necessary. Another direction could be to compare the differential roles of signals from entrepreneurs and investors to further investigate the market mechanism.

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Table 11 (continued)

(Momtaz, 2021)	Promising avenues for future research may include a thorough investigation of the determinants and implications of the empirical return distribution in the ICO market.
(Gächter and Gächter, 2021)	It is up to future research whether commonality, i.e. the “timing factor” is important for STOs and other forms of crypto-based funding.
(Wang and Kogan, 2018) (Ciriello, 2021)	The future research can continue developing the details of blockchain-based continuous monitoring system. There is much to be learned about the design, features, business models, economics, management, organization, legislation, and regulation of Tokenised Index Funds (TIF). IS researchers should engage in multidisciplinary research collaborations with experts in these fields to explore how TIFs can be designed, commercialized, governed, and regulated, and how TIFs would impact retail and institutional investors, intermediaries (such as exchanges, auditors, and service providers), technologies (blockchain, middleware, interfaces, and other systems), and firms (issuers, publicly listed companies, and financial firms).
(Piñeiro-Chousa, 2021)	Future research should consider other variables related to B2B ICOs (team quality, presales, and bonuses), as well as other variables related to the promoter’s country (institutional depth and democracy level). It could also be of interest to analyse other outcomes in relation to marketing objectives.
(Cohen et al., 2021)	Regarding operations strategy for supply chain finance with asset-backed securitization, it will be interesting to consider the possibility of a partial repayment made by the core company. It is also of interest to extend our research to consider supply chains with competition.
(Choi and Ouyang, 2021)	It would be a good idea to study the flexibility of having, e.g., the BPPA platform for online sales or both online and offline channels.
(Momtaz, 2021)	Because it may be difficult to answer all evolving questions on Token-issuing ventures solely based on observable data, qualitative research designs and survey methods may prove useful.
(Fisch, 2019)	Little is known about ICO investors, making it difficult to characterize them convincingly. However, it is absolutely crucial to better understand investors in ICOs in order to more comprehensively understand the dynamics of ICOs. Another crucial avenue for future research is a more careful investigation of the relationship between ICO performance and post ICO performance.
(Bellavitis et al., 2021)	We propose that scholars sort out and differentiate supply of vs. demand for ICO funding, taking geography and regulation into account with a global perspective.
(Belitski and Boreiko, 2021)	Future research will need to focus on the dynamics of investing activity, how it is differentiated across various types of token sale auctions, and the effects of the bonus campaigns on timing, size of investments, and the number of investors. Future scholars may research the post-ICO performance of different types of ICOs and investors. The comparative studies of token sales versus more traditional means such as VC and equity crowdfunding may further extant literature.
(Q. Gan et al. (2021); (J. Gan et al. (2021)	Several assumptions in our model could be relaxed to capture more realistic settings. For instance, the tokens could be used for purposes other than to purchase physical goods; customer willingness to pay and demand could be affected by quite a few factors that we do not capture, including network effects; the success of the ICO could be informative about future demand in a multiperiod setting; investors could have heterogeneous beliefs about product quality; customers could have different valuations for the same product; firms, investors, and/or customers could be risk averse or risk seeking, and so forth. the second would be the need to develop a more elaborate model of secondary market clearing for crypto-currency exchanges.
(Block et al., 2021)	What are the potential benefits and challenges of ICOs? Which types of entrepreneurs seek financing via ICOs? Which business models are funded, and which are not? What is the role of intermediaries in ICOs? & How do ICO investors value firms? How are ICOs priced? How do ICO and CF platforms select firms? How can ICO platforms or websites reduce information asymmetries and moral hazard problems, helping to develop a functioning ICO market and avoiding a market for lemons? On what dimensions do CF and ICOs compete? & Who invests in ICOs, and who invests in CF campaigns? How diversified are these investors? Are they different from investors in “traditional” markets? How do companies decide to deliver voting rights in CF and ICOs? How do investors’ motivations differ between ICOs and CF? & What marketing-related benefits exist with CF and ICOs, and how do they differ between the two forms of entrepreneurial financing?
(Su et al., 2020)	In further research, the relationships between Bitcoin market and other energy or energy assets (e.g., natural gas and energy futures) should be taken into consideration
Cybersecurity and Blockchain Regulation	
(Fisch et al., 2020)	Future studies should further address how to calibrate policy intervention in the context of blockchain finance.
(Y. Chen and Y. Chen (2020); (R.R. Chen and R. R. Chen (2020)	Future research should pay more attention on how to regulate the ICO and cryptocurrency markets.
(Wouda and Opendakker, 2019)	Room for research regarding the effect of privacy regulation on Blockchain technology in commercial real estate transactions still remains.
(Belitski and Boreiko, 2021)	Self-compliance and the effects of legal tools chosen to ensure smooth token sales also represent promising avenues of research
(Hornuf et al., 2021)	Future research could classify the sources of fraud, that is, whether the fraud was planned from the outset or entrepreneurs resorted to fraud during or after the ICO offering.
(Hu et al., 2021)	The inherent risks incorporated with blockchain, and cryptocurrency patent-development should be studied in detail, with particular warnings presented to those companies with no evidence of prior exposure and market knowledge.
(Choi, 2021)	In particular, the use of cryptocurrency may involve many legal and regulatory matters. For example, there are countries and markets in which cryptocurrency is illegal. This will be interesting to examine further in future research.
(Grobys, 2021)	It could be interesting to investigate how Bitcoin volatility behaves at the respective exchange after hacking incidents occurred
(Hua and Huang, 2021)	Future research could focus on how to provide primary solutions to blockchain misuse of private information, financial fraud crimes, money laundering, and so on. Second, there seems to be a lack of research on the most recent evolution of regtech and how it interacts with as well as reshapes fintech market.

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Table 11 (continued)

(Busari and Aminu, 2021)	Future studies need to explore regulators' role and global standards in cross-border issuance of Smart Sukuk with multiple jurisdictions/laws.
Sustainable Blockchain	
(Fisch et al., 2020)	Future studies should further address how blockchain finance, financial inclusion and financial literacy are linked.
(Chen et al., 2021)	For developing financial markets to achieve sustainable economic growth, it is thus proposed that measures be implemented to promote financial development and economic accessibility.
(Mustafa et al., 2021)	There is a clear gap in the literature that focuses on the possibility of using the wealth generated through cryptocurrency trading in financing environmentally friendly projects and attaining the UN's SDG 7 and SDG 13.
(Diniz, 2021)	Future research could explore the social cryptocurrencies phenomenon using the sociomaterial ontology. As organizations behind community currencies seek to improve their scalability without risking their social mission, adopting distributed technology platforms such as blockchain platforms, governance and architecture imbrications in such projects become a matter for continuous investigation
(Polemis and Tsonas, 2021)	his study could be extended to capture possible effects (e.g., integration of renewable energy, power grid optimization, smart management of electricity consumption, integration of distributed energy sources and data management) of the environmental consequences of the Information and Communication Technologies (ICT). It is noteworthy that the environmental implications of ICT have not been heavily studied, and the ongoing research targeted at the energy/environmental impacts of ICT is still limited.
(Mohsin et al., 2020)	The environmental impact of blockchain adoption is proxied by CO2 emission while other environmental emissions like nitrogen oxide (NO + NO2), sulphur dioxide (SO), ozone (O3), carbon monoxide (CO), non-methane hydrocarbons (VOC), methane (CH4), chlorofluorocarbons (CFC), and particulates also contribute in environmental damages.
(Mohd Nor et al., 2021)	Future research should be towards developing an exclusive zakah blockchain model that could benefit society. This study should include important stakeholders i.e. the government agencies, zakah institutions and fintech experts to build a comprehensive zakah blockchain model that could enhance the effectiveness of the zakah management system.

The table shows the future research directions identified by the content analysis and the meta-literature review.

might alleviate cryptos' carbon footprint. Another possible solution to this issue is the allocation of part of the revenues or "green commissions" to the pursuit of initiatives related to climate action or to the United Nations' (UN) sustainable development goals. Environmental pollution is not the only controversial aspect of blockchain applications, which are liable to illegal misuse, as discussed in paragraph 5.3. For instance, cryptocurrencies may be used for antisocial/unethical purposes in the dark net, shadow banking, or for money laundering (Dierksmeier and Seele, 2018). Despite the questionable reputation, blockchain technology can easily find pro-social applications, as suggested by the extant literature (e.g., Kowalski et al., 2021). For instance, as discussed in paragraph 5.2.1 and 5.2.3, blockchain financial applications may be used to considerably reduce the average cost of financial services, thereby enhancing financial inclusion (Chen et al., 2021). Moreover, thanks to some blockchain applications, such as ICOs (see paragraph 5.3.2), distributed ledger technologies have empowered financially excluded individuals with entrepreneurial ambitions. Larios Hernández (2017) concludes that "Blockchain entrepreneurship can generate semi-formal financial services that bring financial aspirations closer to people" clearly enhancing financial inclusion. On the same line, Hua and Hiang (2021) recognise the promotion of financial inclusion among the most relevant benefits of FinTech and blockchain financial applications in China, as it manages to enable a vast number of small and medium-sized enterprises (SMEs) and low-income households to access to financial services. Moreover, the authors recognise to distributed ledger technology the potential to push the frontier of credit availability closer to individuals and firms with low credit worthiness. Another relevant case study (i.e., Schuetz and Venkatesh, 2020) provides evidence of the role played by blockchain in alleviating financial exclusion in rural India, by potentially connecting unbanked individuals to global supply chain networks. Unfortunately, thought, the authors recognise that education and infrastructure gaps need to be filled before being able to put this ambitious plan into practice. The potential positive applications of blockchain in impact investing and sustainable investing are numerous and notably include microfinance (Tsao and Vu, 2021) and microinsurance, but also solidarity cryptocurrencies (Diniz et al., 2021), similar to traditional community currencies but based on a blockchain. Very close to microfinance and solidarity cryptocurrencies research is a sub-stream dealing with Shari'a compliant blockchain solutions. Khan et al. (2020) elaborate a taxonomy for blockchain applications in the Islamic finance context. Moreover, the authors experiment the tokenization of Sukuk al-Murabaha on Ethereum and coded a basic Shari'a compliant smart contract and find two main obstacles that need to be overcome before Islamic blockchain-based financial solutions may have a foothold. Namely, according to the authors, developers with the necessary IT skills are not readily available and specific regulation is needed to protect investors' interests. In contrast, other authors (e.g., Delle Foglie et al., 2021; Busari and Aminu, 2021), provide a more possibilist view on Smart Sukuk, which may provide a solution to major criticisms and challenges of the traditional Sukuk industry arising from contractual issues and ambiguities. Specifically, Smart Sukuks may solve a wide array of issues due to Shari'a interpretations, jurisdictional policies and legal issues, which affect Sukuk origination notably on the right of investors in the event of Sukuk defaults, overall resetting the risk of gharar and maysir fundamentals. In a Malaysian case study, Nor et al., (2021) focus their research on the application of blockchain technology in zakah management, finding that, especially during the pandemic, the contactless approach of blockchain applied to zakah institutions appeal both receivers and payers. Overall, the actual possibility of conciliate the Shari'a principles with the technicalities of blockchain remains unclear; the two main challenges refer to the possibility for Shari'a principles to be computationally encoded, whereas the second one calls into question the principles of Maqasid al-Shari'a, according to which transactions should not harm society and the

unsolved environmental and social issues associated with blockchain financial applications pose problems in this regard (Chong, 2021).

6. Future research agenda

The four research areas commented under paragraph 5, provide some thoughtful insights on the changing in the landscape of the banking industry, the numerous possible financial applications of distributed ledger technologies, cybersecurity opportunities and threats and regulation changings required by this disruptive innovation, as well as the pros and cons of blockchain adoption in banking and finance in terms of sustainability. The review and the analysis of the extant literature, though provide some inspirational open questions and suggestions for future research in the field, as well that are gathered in Table 11. An overview of the future research agenda highlights, among other topics, the need for cross-country analyses, which may shed light on the case studies' findings generalisation, a gap in the literature on possible way to regulate and supervise the blockchain applications and the call for a multi-disciplinary approach to the topic.

7. Conclusions

The present paper performs a meta-bibliometric analysis on the blockchain technology in banking and finance literature, using both the qualitative and quantitative techniques. We analysed 154 articles from the Elsevier Scopus and Web of Science databases covering the period 2008–2021. We selected quality papers published in ABS ranked journals after a three-step filtering process: (1) removing duplicates, (2) removing irrelevant papers and (3) removing the papers published in non-ABS ranked journals. We used the VOSviewer software for the bibliometric analysis and provide a meta-literature review focusing on: (1) Influential countries, (2) Influential journals, (3) Influential authors-articles-institutions, (4) Co-authorship analysis, (5) Cartographic analysis, (6) Co-citation analysis, and (7) Bibliographic coupling analysis. We also provide a content analysis of the four streams that constitutes the literature: blockchain impact on financial intermediation, technical applications of distributed ledger technologies in finance, cybersecurity and regulation and lastly the relationship between sustainability and blockchain applications in banking and finance. To conclude, we present some possible directions for future research that leverage contributions from the whole academic literature that deals with blockchain antecedents, applications, and consequences of blockchain technology in banking and finance. The three main research streams that remain unanswered regard possible way to regulate and supervise the blockchain applications, the need for cross-country analyses on the development of such applications and the benefit that a multi-disciplinary approach to the topic may bring to the literature.

CRedit authorship contribution statement

Ritesh Petel: Software, Methodology, Writing – original draft. **Milena Migliavacca:** Conceptualization, Data curation, Writing – original draft, Writing – review & editing. **Marco Oriani:** Supervision.

Data Availability

No data was used for the research described in the article.

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References

- Adel, H., Younis, R.A.A., 2021. Interplay among blockchain technology adoption strategy, e-supply chain management diffusion, entrepreneurial orientation and human resources information system in banking. *Int. J. Emerg. Mark.* <https://doi.org/10.1108/IJOEM-02-2021-0165>.
- Adhami, S., Giudici, G., Martinazzi, S., 2018. Why do businesses go crypto? An empirical analysis of initial coin offerings. *J. Econ. Bus.* 100, 64–75.
- Ahluwalia, S., Mahto, R.V., Guerrero, M., 2020. Blockchain technology and start-up financing: a transaction cost economics perspective. *Technol. Forecast. Soc. Change* 151, 119854. <https://doi.org/10.1016/j.techfore.2019.119854>.
- An, J., Rau, R., 2021. Finance, technology and disruption. *Eur. J. Financ.* 27 (4–5), 334–345. <https://doi.org/10.1080/1351847X.2019.1703024>.
- Ante, L., Fiedler, I., Strehle, E., 2021. The influence of stable coin issuances on cryptocurrency markets. *Financ. Res. Lett.* 41, 101867 <https://doi.org/10.1016/j.frl.2020.101867>.
- Bahoo, S., Alon, I., Paltrinieri, A., 2020. Corruption in international business: a review and research agenda. *Int. Bus. Rev.* 29 (4), 101660 <https://doi.org/10.1016/j.ibusrev.2019.101660>.
- Ball, Rafael, Tunger, Dirk, 2006. Science indicators revisited—Science Citation Index versus SCOPUS: A bibliometric comparison of both citation databases. *Information Services & Use*.
- Barrdear, J., Kumhof, M., 2021. The macroeconomics of central bank digital currencies. *J. Econ. Dyn. Control*, 104148. <https://doi.org/10.1016/j.jedc.2021.104148>.
- Beigman, E., Brennan, G., Hsieh, S.F., Sannella, A.J., 2021. Dynamic principal market determination: fair value measurement of cryptocurrency. *J. Account., Audit. Financ.* 0148558X211004134. <https://doi.org/10.1177%2F0148558X211004134>.
- Belitski, M., Boreiko, D., 2021. Success factors of initial coin offerings. *J. Technol. Transf.* 1–17. <https://doi.org/10.1007/s10961-021-09894-x>.
- Bellavitis, C., Fisch, C., Wiklund, J., 2021. A comprehensive review of the global development of initial coin offerings (ICOs) and their regulation. *J. Bus. Ventur. Insights* 15, e00213. <https://doi.org/10.1016/j.jbvi.2020.e00213>.

- Benedetti, H., Nikbakht, E., 2021. Returns and network growth of digital tokens after cross-listings. *J. Corp. Financ.* 66, 101853 <https://doi.org/10.1016/j.jcorpfin.2020.101853>.
- Block, J.H., Colombo, M.G., Cumming, D.J., Vismara, S., 2018. New players in entrepreneurial finance and why they are there. *Small Bus. Econ.* 50 (2), 239–250.
- Block, J.H., Groh, A., Hornuf, L., Vanacker, T., Vismara, S., 2021. The entrepreneurial finance markets of the future: a comparison of crowdfunding and initial coin offerings. *Small Bus. Econ.* 57 (2), 865–882. <https://doi.org/10.1007/s11187-020-00330-2>.
- Busari, S.A., Aminu, S.O., 2021. Application of blockchain information technology in Şukük trade. *J. Islam. Account. Bus. Res.* 13 (1), 1–15. <https://doi.org/10.1108/JIABR-10-2019-0197>.
- Cai, C.W., 2018. Disruption of financial intermediation by FinTech: a review on crowdfunding and blockchain. *Account. Financ.* 58 (4), 965–992. <https://doi.org/10.1111/acfi.12405>.
- Campino, J., Brochado, A., Rosa, Á., 2021. Initial Coin Offerings (ICOs): the importance of human capital. *J. Bus. Econ.* 1–38. <https://doi.org/10.1007/s11573-021-01037-w>.
- Cao, S., Lyu, H., Xu, X., 2020. InsurTech development: evidence from Chinese media reports. *Technol. Forecast. Soc. Change* 161, 120277. <https://doi.org/10.1016/j.techfore.2020.120277>.
- Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., Arami, M., 2020. How Blockchain can impact financial services—the overview, challenges and recommendations from expert interviewees. *Technol. Forecast. Soc. Change* 158, 120166. <https://doi.org/10.1016/j.techfore.2020.120166>.
- Chen, K., 2019. Information asymmetry in initial coin offerings (ICOs): investigating the effects of multiple channel signals. *Electron. Commer. Res. Appl.* 36, 100858 <https://doi.org/10.1016/j.elerap.2019.100858>.
- Chen, R.R., Chen, K., 2020. A 2020 perspective on “Information asymmetry in initial coin offerings (ICOs): investigating the effects of multiple channel signals”. *Electron. Commer. Res. Appl.* 40, 100936 <https://doi.org/10.1016/j.elerap.2020.100936>.
- Chen, Y., Bellavitis, C., 2020. Blockchain disruption and decentralized finance: the rise of decentralized business models. *J. Bus. Ventur. Insights* 13, e00151. <https://doi.org/10.1016/j.jbvi.2019.e00151>.
- Cheng, M., Qu, Y., 2020. Does bank FinTech reduce credit risk? Evidence from China. *Pac. Basin Financ. J.* 63, 101398 <https://doi.org/10.1016/j.pacfin.2020.101398>.
- Chiu, J., Koeppl, T.V., 2019. Blockchain-based settlement for asset trading. *Rev. Financ. Stud.* 32 (5), 1716–1753.
- Chod, J., Trichakis, N., Tsoukalas, G., Aspegren, H., Weber, M., 2020. On the financing benefits of supply chain transparency and blockchain adoption. *Manag. Sci.* 66 (10), 4378–4396. <https://doi.org/10.1287/mnsc.2019.3434>.
- Choi, T.M., 2021. Creating all-win by blockchain technology in supply chains: impacts of agents’ risk attitudes towards cryptocurrency. *J. Oper. Res. Soc.* 72 (11), 2580–2595. <https://doi.org/10.1080/01605682.2020.1800419>.
- Choi, T.M., Ouyang, X., 2021. Initial coin offerings for blockchain based product provenance authentication platforms. *Int. J. Prod. Econ.* 233, 107995 <https://doi.org/10.1016/j.ijpe.2020.107995>.
- Chong, A.Y.L., Lim, E.T., Hua, X., Zheng, S., Tan, C.W., 2019. Business on chain: a comparative case study of five blockchain-inspired business models. *J. Assoc. Inf. Syst.* 20 (9), 9–18. <https://doi.org/10.17705/1jais.00568>.
- Chong, F.H.L., 2021. Enhancing trust through digital Islamic finance and blockchain technology. *Qual. Res. Financ. Mark.* 13 (3), 328–341. <https://doi.org/10.1108/QRFM-05-2020-0076>.
- Cioroianu, I., Corbet, S., Larkin, C., 2021. The differential impact of corporate blockchain-development as conditioned by sentiment and financial desperation. *J. Corp. Financ.* 66, 101814 <https://doi.org/10.1016/j.jcorpfin.2020.101814>.
- Ciriello, R.F., 2021. Tokenized index funds: a blockchain-based concept and a multidisciplinary research framework. *Int. J. Inf. Manag.* 61, 102400 <https://doi.org/10.1016/j.ijinfomgt.2021.102400>.
- Corbet, S., Lucey, B., Urquhart, A., Yarovaya, L., 2019. Cryptocurrencies as a financial asset: a systematic analysis. *Int. Rev. Financ. Anal.* 62, 182–199.
- Csóka, P., Jean-Jacques Herings, P., Herings, Jean-Jacques, 2018. Decentralized clearing in financial networks. *Manag. Sci.* 64 (10), 4681–4699.
- Cucari, N., Lagasio, V., Lia, G., Torriero, C., 2021. The impact of blockchain in banking processes: the Interbank Spunta case study. *Technol. Anal. Strateg. Manag.* 1–13. <https://doi.org/10.1080/09537325.2021.1891217>.
- Cucculelli, M., Recanatini, M., 2021. Distributed Ledger technology systems in securities post-trading services. evidence from European global systemic banks. *Eur. J. Financ.* 1–24. <https://doi.org/10.1080/1351847X.2021.1921002>.
- Cukierman, A., 2020. Reflections on welfare and political economy aspects of a central bank digital currency. *Manch. Sch.* 88, 114–125. <https://doi.org/10.1111/manc.12333>.
- Dai, J., Vasarhelyi, M.A., 2017. Toward blockchain-based accounting and assurance. *J. Inf. Syst.* 31 (3), 5–21.
- Dashottar, S., Srivastava, V., 2021. Corporate banking—risk management, regulatory and reporting framework in India: a blockchain application-based approach. *J. Bank. Regul.* 22 (1), 39–51. <https://doi.org/10.1057/s41261-020-00127-z>.
- Delle Foglie, A., Panetta, I.C., Boukrami, E., Vento, G., 2021. The impact of the Blockchain technology on the global Sukuk industry: smart contracts and asset tokenisation. *Technol. Anal. Strateg. Manag.* 1–15. <https://doi.org/10.1080/09537325.2021.1939000>.
- Dicuozzo, G., Donofrio, F., Fusco, A., Dell’Atti, V., 2021. Blockchain technology: opportunities and challenges for small and large banks during COVID-19. *Int. J. Innov. Technol. Manag.* 2140001 <https://doi.org/10.1142/S0219877021400010>.
- Dierksmeier, C., Seele, P., 2018. Cryptocurrencies and business ethics. *J. Bus. Ethics* 152 (1), 1–14. <https://doi.org/10.1007/s10551-016-3298-0>.
- Diniz, E.H., Cernev, A.K., Rodrigues, D.A., Daneluzzi, F., 2021. Solidarity cryptocurrencies as digital community platforms. *Inf. Technol. Dev.* 27 (3), 524–538. <https://doi.org/10.1080/02681102.2020.1827365>.
- Du, M., Chen, Q., Xiao, J., Yang, H., Ma, X., 2020. Supply chain finance innovation using blockchain. *IEEE Trans. Eng. Manag.* 67 (4), 1045–1058.
- Erol, I., Ar, I.M., Ozdemir, A.I., Peker, I., Asgary, A., Medeni, I.T., Medeni, T., 2020. Assessing the feasibility of blockchain technology in industries: evidence from Turkey. *J. Enterp. Inf. Manag.* 34 (3), 746–769. <https://doi.org/10.1108/JEIM-09-2019-0309>.
- Eyal, I., 2017. Blockchain technology: transforming libertarian cryptocurrency dreams to finance and banking realities. *Computer* 50 (9), 38–49.
- Feng, Y., Zhu, Q., Lai, K.H., 2017. Corporate social responsibility for supply chain management: a literature review and bibliometric analysis. *J. Clean. Prod.* 158, 296–307.
- Firdaus, A., Razak, M.F.A., Feizollah, A., Hashem, I.A.T., Hazim, M., Anuar, N.B., 2019. The rise of “blockchain”: bibliometric analysis of blockchain study. *Scientometrics* 120 (3), 1289–1331.
- Fisch, C., 2019. Initial coin offerings (ICOs) to finance new ventures. *J. Bus. Ventur.* 34 (1), 1–22. <https://doi.org/10.1016/j.jbusvent.2018.09.007>.
- Fisch, C., Meoli, M., Vismara, S., 2020. Does blockchain technology democratize entrepreneurial finance? An empirical comparison of ICOs, venture capital, and REITs. *Econ. Innov. New Technol.* 1–20. <https://doi.org/10.1080/10438599.2020.1843991>.
- Flori, A., 2019. Cryptocurrencies in finance: review and applications. *Int. J. Theor. Appl. Financ.* 22 (05), 1950020 <https://doi.org/10.1142/S0219024919500201>.
- Gächter, I., Gächter, M., 2021. Success factors in ICOs: individual firm characteristics or lucky timing? *Financ. Res. Lett.* 40, 101715 <https://doi.org/10.1016/j.frl.2020.101715>.
- Gan, J., Tsoukalas, G., Netessine, S., 2021. Initial coin offerings, speculation, and asset tokenization. *Manag. Sci.* 67 (2), 914–931. <https://doi.org/10.1287/mnsc.2020.3796>.
- Gan, Q., Lau, R.Y.K., Hong, J., 2021. A critical review of blockchain applications to banking and finance: a qualitative thematic analysis approach. *Technol. Anal. Strateg. Manag.* 1–17. <https://doi.org/10.1080/09537325.2021.1979509>.
- Garg, P., Gupta, B., Chauhan, A.K., Sivarajah, U., Gupta, S., Modgil, S., 2021. Measuring the perceived benefits of implementing blockchain technology in the banking sector. *Technol. Forecast. Soc. Change* 163, 120407. <https://doi.org/10.1016/j.techfore.2020.120407>.
- Gomber, P., Kauffman, R.J., Parker, C., Weber, B.W., 2018. On the fintech revolution: interpreting the forces of innovation, disruption, and transformation in financial services. *J. Manag. Inf. Syst.* 35 (1), 220–265. <https://doi.org/10.1080/07421222.2018.1440766>.
- Griffin, J.M., Shams, A., 2020. Is Bitcoin really untethered? *J. Financ.* 75 (4), 1913–1964. <https://doi.org/10.1111/jofi.12903>.

- Grobys, K., 2021. When the blockchain does not block: on hackings and uncertainty in the cryptocurrency market. *Quant. Financ.* 1–13. <https://doi.org/10.1080/14697688.2020.1849779>.
- Grover, P., Kar, A.K., Janssen, M., 2019. Diffusion of blockchain technology: Insights from academic literature and social media analytics. *J. Enterp. Inf. Manag.* 32 (5), 735–757. <https://doi.org/10.1108/JEIM-06-2018-0132>.
- Guerar, M., Merlo, A., Migliardi, M., Palmieri, F., Verderame, L., 2020. A fraud-resilient blockchain-based solution for invoice financing. *IEEE Trans. Eng. Manag.* 67 (4), 1086–1098.
- Guo, Y., Liang, C., 2016. Blockchain application and outlook in the banking industry. *Financ. Innov.* 2 (1), 1–12.
- Gurdgiev, C., O'Loughlin, D., 2020. Herding and anchoring in cryptocurrency markets: investor reaction to fear and uncertainty. *J. Behav. Exp. Financ.* 25, 100271 <https://doi.org/10.1016/j.jbef.2020.100271>.
- Hackober, C., Bock, C., 2021. Which investors' characteristics are beneficial for initial coin offerings? Evidence from blockchain technology-based firms. *J. Bus. Econ.* 1–40.
- Haffke, Lars and Fromberger, Mathias, ICO Market Report 2019/2020 – Performance Analysis of 2019's Initial Coin Offerings (December 30, 2020). Available at SSRN: <https://ssrn.com/abstract=3770793> or <https://doi.org/10.2139/ssrn.3770793>.
- Harris, W.L., Wonglimpiyarat, J., 2019. Blockchain platform and future bank competition. *Foresight* 21 (6), 625–639. <https://doi.org/10.1108/FS-12-2018-0113>.
- Hendershott, T., Zhang, X., Zhao, J.L., Zheng, Z., 2021. FinTech as a game changer: overview of research frontiers. *Inf. Syst. Res.* 32 (1), 1–17. <https://doi.org/10.1287/isre.2021.0997>.
- Holub, M., Johnson, J., 2018. Bitcoin research across disciplines. *Inf. Soc.* 34 (2), 114–126. <https://doi.org/10.1080/01972243.2017.1414094>.
- Hornuf, L., Kück, T., Schwienbacher, A., 2021. Initial coin offerings, information disclosure, and fraud. *Small Bus. Econ.* 1–19. <https://doi.org/10.1007/s11187-021-00471-y>.
- Howell, S.T., Niessner, M., Yermack, D., 2020. Initial coin offerings: Financing growth with cryptocurrency token sales. *Rev. Financ. Stud.* 33 (9), 3925–3974. <https://doi.org/10.1093/rfs/hhz131>.
- Hu, Y., Hou, Y.G., Oxley, L., Corbet, S., 2021. Does blockchain patent-development influence Bitcoin risk? *J. Int. Financ. Mark., Inst. Money* 70, 101263. <https://doi.org/10.1016/j.intfin.2020.101263>.
- Hua, X., Huang, Y., 2021. Understanding China's fintech sector: development, impacts and risks. *Eur. J. Financ.* 27 (4–5), 321–333. <https://doi.org/10.1080/1351847X.2020.1811131>.
- Huang, W., Meoli, M., Vismara, S., 2020. The geography of initial coin offerings. *Small Bus. Econ.* 55 (1), 77–102. <https://doi.org/10.1007/s11187-019-00135-y>.
- Katsiampa, P., 2017. Volatility estimation for Bitcoin: a comparison of GARCH models. *Econ. Lett.* 158, 3–6.
- Khan, N., Kchouri, B., Yatoo, N.A., Kräussl, Z., Patel, A., State, R., 2020. Tokenization of sukuk: ethereum case study. *Glob. Financ. J.*, 100539 <https://doi.org/10.1016/j.gfj.2020.100539>.
- Kimani, D., Adams, K., Attah-Boakye, R., Ullah, S., Frecknall-Hughes, J., Kim, J., 2020. Blockchain, business and the fourth industrial revolution: whence, whither, wherefore and how? *Technol. Forecast. Soc. Change* 161, 120254. <https://doi.org/10.1016/j.techfore.2020.120254>.
- Kowalski, M., Lee, Z.W., Chan, T.K., 2021. Blockchain technology and trust relationships in trade finance. *Technol. Forecast. Soc. Change* 166, 120641. <https://doi.org/10.1016/j.techfore.2021.120641>.
- Kraimer, R.E., 2017. Economic stability under alternative banking systems: theory and policy. *J. Financ. Stab.* 31, 107–118. <https://doi.org/10.1016/j.jfs.2017.05.005>.
- Larios-Hernández, G.J., 2017. Blockchain entrepreneurship opportunity in the practices of the unbanked. *Bus. Horiz.* 60 (6), 865–874. <https://doi.org/10.1016/j.bushor.2017.07.012>.
- Le Penec, G., Fiedler, L., Ante, L., 2021. Wash trading at cryptocurrency exchanges. *Financ. Res. Lett.*, 101982 <https://doi.org/10.1016/j.frl.2021.101982>.
- Levasseur, L., Johan, S., Eckhardt, J., 2021. Mixed methods in venture capital research: an illustrative study and directions for future work. *Br. J. Manag.* <https://doi.org/10.1111/1467-8551.12514>.
- Malherbe, L., Montalban, M., Bédou, N., Granier, C., 2019. Cryptocurrencies and blockchain: opportunities and limits of a new monetary regime. *Int. J. Political Econ.* 48 (2), 127–152. <https://doi.org/10.1080/08911916.2019.1624320>.
- Marchiori, Danilo, Franco, Mário, 2020. Knowledge transfer in the context of inter-organizational networks: Foundations and intellectual structures. *Journal of Innovation & Knowledge*.
- Marthinsen, J.E., Gordon, S.R., 2020. Hyperinflation, optimal currency scopes, and a cryptocurrency alternative to dollarization. *Q. Rev. Econ. Financ.* <https://doi.org/10.1016/j.qref.2020.12.007>.
- Milian, E.Z., Spinola, M.D.M., de Carvalho, M.M., 2019. Fintechs: a literature review and research agenda. *Electron. Commer. Res. Appl.* 34, 100833 <https://doi.org/10.1016/j.elerap.2019.100833>.
- Mills, D.C., Wang, K., Malone, B., et al., 2017. Distributed ledger technology in payments, clearing, and settlement. *J. Financ. Mark. Infrastruct.* 6 (2–3), 207–249.
- Mishra, L., Kaushik, V., 2021. Application of blockchain in dealing with sustainability issues and challenges of financial sector. *J. Sustain. Financ. Invest.* 1–16. <https://doi.org/10.1080/20430795.2021.1940805>.
- Mohsin, M., Naseem, S., Zia-ur-Rehman, M., Baig, S.A., Salamat, S., 2020. The crypto-trade volume, GDP, energy use, and environmental degradation sustainability: An analysis of the top 20 crypto-trader countries. *Int. J. Financ. Econ.* <https://doi.org/10.1002/ijfe.2442>.
- Momtaz, P.P., 2021. Entrepreneurial finance and moral hazard: evidence from token offerings. *J. Bus. Ventur.* 36 (5), 106001 <https://doi.org/10.1016/j.jbusvent.2020.106001>.
- Mustafa, F., Lodh, S., Nandy, M., Kumar, V., 2021. Coupling of cryptocurrency trading with the sustainable environmental goals: is it on the cards? *Bus. Strategy Environ.* <https://doi.org/10.1002/bse.2947>.
- Nadler, P., Guo, Y., 2020. The fair value of a token: How do markets price cryptocurrencies? *Res. Int. Bus. Financ.* 52, 101108 <https://doi.org/10.1016/j.ribaf.2019.101108>.
- Naimi-Sadigh, A., Asgari, T., Rabiei, M., 2021. Digital transformation in the value chain disruption of banking services. *J. Knowl. Econ.* 1–31. <https://doi.org/10.1007/s13132-021-00759-0>.
- Nikbakht, E., Shahrokhi, M., Corriette, A., 2019. Blockchain & distributed financial data. *Manag. Financ.* 46 (6), 749–760. <https://doi.org/10.1108/MF-10-2018-0470>.
- Nor, S.M., Abdul-Majid, M., Esrati, S.N., 2021. The role of blockchain technology in enhancing Islamic social finance: the case of Zakah management in Malaysia. *foresight* 23 (5), 509–527. <https://doi.org/10.1108/FS-06-2020-0058>.
- Nor, Shifa Mohd, Abdul-Majid, Mariani, Esrati, Siti Nabihah, 2021. The role of blockchain technology in enhancing Islamic social finance: the case of Zakah management in Malaysia. *foresight*.
- O'Dair, M., Owen, R., 2019. Financing new creative enterprise through blockchain technology: opportunities and policy implications. *Strateg. Change* 28 (1), 9–17. <https://doi.org/10.1002/jsc.2242>.
- Osmani, M., El-Haddadeh, R., Hindi, N., Janssen, M., Weerakkody, V., 2020. Blockchain for next generation services in banking and finance: cost, benefit, risk and opportunity analysis. *J. Enterp. Inf. Manag.* 34 (3), 884–899. <https://doi.org/10.1108/JEIM-02-2020-0044>.
- Papadimitriou, T., Gogas, P., Agravetidou, A., 2020. The resilience of the US banking system. *Int. J. Financ. Econ.* <https://doi.org/10.1002/ijfe.2300>.
- Parlina, Anne, et al., 2020. Theme mapping and bibliometrics analysis of one decade of big data research in the scopus database. *Information*.
- Pele, D.T., Wesselhöft, N., Hårdle, W.K., Kolossiat, M., Yatracos, Y.G., 2021. Are cryptos becoming alternative assets? *Eur. J. Financ.* 1–42. <https://doi.org/10.1080/1351847X.2021.1960403>.
- Petukhina, A., Trimborn, S., Hårdle, W.K., Elendner, H., 2021. Investing with cryptocurrencies—evaluating their potential for portfolio allocation strategies. *Quant. Financ.* 1–29. <https://doi.org/10.1080/14697688.2021.1880023>.
- Piñeiro-Chousa, J., López-Cabarcos, M.Á., Ribeiro-Soriano, D., 2021. The influence of financial features and country characteristics on B2B ICOs' website traffic. *Int. J. Inf. Manag.* 59, 102332 <https://doi.org/10.1016/j.ijinfomgt.2021.102332>.

- Polemis, M.L., Tsionas, M.G., 2021. The environmental consequences of blockchain technology: a bayesian quantile cointegration analysis for Bitcoin. *Int. J. Financ. Econ.* <https://doi.org/10.1002/ijfe.2496>.
- Rahman, A., Abedin, M.J., 2021. The Fourth Industrial Revolution and private commercial banks: the good, bad and ugly. *Int. J. Organ. Anal.* 29 (5), 1287–1301. <https://doi.org/10.1108/IJOA-05-2020-2218>.
- Rajnak, V., Puschmann, T., 2021. The impact of blockchain on business models in banking. *Inf. Syst. e-Bus. Manag.* 19 (3), 809–861. <https://doi.org/10.1007/s10257-020-00468-2>.
- Rijanto, A., 2021. Blockchain technology adoption in supply chain finance. *J. Theor. Appl. Electron. Commer. Res.* 16 (7), 3078–3098.
- Risius, M., Spohrer, K., 2017. A blockchain research framework. *Bus. Inf. Syst. Eng.* 59 (6), 385–409.
- Rossi, A., Vismara, S., 2018. What do crowdfunding platforms do? A comparison between investment-based platforms in Europe. *Eurasia Bus. Rev.* 8 (1), 93–118.
- Roşu, I., Saleh, F., 2021. Evolution of shares in a proof-of-stake cryptocurrency. *Manag. Sci.* 67 (2), 661–672. <https://doi.org/10.1287/mnsc.2020.3791>.
- Saheb, T., Mamaghani, F.H., 2021. Exploring the barriers and organizational values of blockchain adoption in the banking industry. *J. High. Technol. Manag. Res.*, 100417 <https://doi.org/10.1016/j.hitech.2021.100417>.
- Sargent, C.S., 2021. Replacing financial audits with blockchain: the verification issue. *J. Comput. Inf. Syst.* 1–9. <https://doi.org/10.1080/08874417.2021.1992805>.
- Satoshi, N., 2008. Bitcoin: a peer-to-peer electronic cash system, Consulted 1, 2012. Schwiendbacher, A., and B. Larraalde, 2012, Alternative Types of Entrepreneurial Finance.
- Saull, A., Baum, A., Braesemann, F., 2020. Can digital technologies speed up real estate transactions? *J. Prop. Invest. Financ.* 38 (4), 349–361. <https://doi.org/10.1108/JPIF-09-2019-0131>.
- Savona, P., 2021. Prospects for reforming the money and financial system. *Open Econ. Rev.* 1–9. <https://doi.org/10.1007/s11079-021-09628-4>.
- Schückes, M., Gutmann, T., 2021. Why do startups pursue initial coin offerings (ICOs)? The role of economic drivers and social identity on funding choice. *Small Bus. Econ.* 57 (2), 1027–1052. <https://doi.org/10.1007/s11187-020-00337-9>.
- Schuetz, S., Venkatesh, V., 2020. Blockchain, adoption, and financial inclusion in India: research opportunities. *Int. J. Inf. Manag.* 52, 101936 <https://doi.org/10.1016/j.ijinfomgt.2019.04.009>.
- Shanaev, S., Sharma, S., Ghimire, B., Shuraeva, A., 2020. Taming the blockchain beast? Regulatory implications for the cryptocurrency Market. *Res. Int. Bus. Financ.* 51, 101080 <https://doi.org/10.1016/j.ribaf.2019.101080>.
- Sharma, Z., Zhu, Y., 2020. Platform building in initial coin offering market: empirical evidence. *Pac. Basin Financ. J.* 61, 101318 <https://doi.org/10.1016/j.pacfin.2020.101318>.
- Sheth, A., Subramanian, H., 2019. Blockchain and contract theory: modeling smart contracts using insurance markets. *Manag. Financ.* 46 (6), 803–814. <https://doi.org/10.1108/MF-10-2018-0510>.
- Small, H., 1973. Co-citation in the scientific literature: a new measure of the relationship between two documents. *J. Am. Soc. Inf. Sci.* 24 (4), 265–269.
- Smith, K.J., Dhillon, G., 2019. Assessing blockchain potential for improving the cybersecurity of financial transactions. *Manag. Financ.* 46 (6), 833–848. <https://doi.org/10.1108/MF-06-2019-0314>.
- Su, C.W., Qin, M., Tao, R., Umar, M., 2020. Financial implications of fourth industrial revolution: can bitcoin improve prospects of energy investment? *Technol. Forecast. Soc. Change* 158, 120178. <https://doi.org/10.1016/j.techfore.2020.120178>.
- Sun, R., He, D., Su, H., 2021. Evolutionary game analysis of blockchain technology preventing supply chain financial risks. *J. Theor. Appl. Electron. Commer. Res.* 16 (7), 2824–2842.
- Thakor, A.V., 2020. Fintech and banking: what do we know? *J. Financ. Inter.* 41, 100833 <https://doi.org/10.1016/j.jfi.2019.100833>.
- Treleaven, P., Brown, R.G., Yang, D., 2017. Blockchain technology in finance. *Computer* 50 (9), 14–17.
- Tsao, Y.C., Vu, T.L., 2021. A decentralized microgrid considering blockchain adoption and credit risk. *J. Oper. Res. Soc.* 1–13. <https://doi.org/10.1080/01605682.2021.1960907>.
- Van Eck, N.J., Waltman, L., 2010. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics* 84 (2), 523–538.
- Van Eck, N.J., Waltman, L., 2014. Visualizing bibliometric networks. *Meas. Sch. Impact Springe* 285–320.
- Vismara, S., 2018. Information cascades among investors in equity crowdfunding. *Entrep. Theory Pract.* 42 (3), 467–497.
- Wang, L., Luo, X.R., Lee, F., Benitez, J., 2021. Value creation in blockchain-driven supply chain finance. *Inf. Manag.*, 103510 <https://doi.org/10.1016/j.im.2021.103510>.
- Wang, Y., Kogan, A., 2018. Designing confidentiality-preserving Blockchain-based transaction processing systems. *Int. J. Account. Inf. Syst.* 30, 1–18. <https://doi.org/10.1016/j.accinf.2018.06.001>.
- Worzala, E., Souza, L.A., Koroleva, O., Becker, A., Derrick, N., 2020. The technological impact on real estate investing: robots vs humans: new applications for organisational and portfolio strategies. *J. Prop. Invest. Financ.* 39 (2), 170–177. <https://doi.org/10.1108/JPIF-12-2020-0137>.
- Wouda, H.P., Opendakker, R., 2019. Blockchain technology in commercial real estate transactions. *J. Prop. Invest. Financ.* 37 (6), 570–579. <https://doi.org/10.1108/JPIF-06-2019-0085>.
- Yang, D., Li, M., 2018. Evolutionary approaches and the construction of technology-driven regulations. *Emerg. Mark. Financ. Trade* 54 (14), 3256–3271. <https://doi.org/10.1080/1540496X.2018.1496422>.
- Yermack, D., 2017. Corporate governance and blockchains. *Rev. Financ.* 21 (1), 7–31. <https://doi.org/10.1093/rof/rfw074>.
- Zhang, L., Xie, Y., Zheng, Y., Xue, W., Zheng, X., Xu, X., 2020. The challenges and countermeasures of blockchain in finance and economics. *Syst. Res. Behav. Sci.* 37 (4), 691–698. <https://doi.org/10.1002/sres.2710>.
- Zhang, S., Zhang, D., Zheng, J., Aerts, W., 2021. Does policy uncertainty of the blockchain dampen ICO markets? *Account. Financ.* 61, 1625–1637. <https://doi.org/10.1111/acfi.12639>.
- Zhang, S., Aerts, W., Zhang, D., Chen, Z., 2021. Positive tone and initial coin offering. *Account. Financ.* <https://doi.org/10.1111/acfi.12860>.