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A comprehensive bibliometric analysis of financial innovation

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ABSTRACT

Derived from the viewpoint put forward by Joseph Alois Schumpeter in 1912, financial innovation (FI) has made great achievements, mainly reflected in the innovations of organisation system, management, financial market, financial business and instruments, and financial technology, etc. Based on the existing publications in the field of FI, this paper conducts a comprehensive analysis and discussion. Firstly, according to the Web of Science (WoS), 1,341 publications are obtained. Considering the foundational characteristics, citation structure and cooperation relationship of publications, the bibliometric analysis results are presented at the levels of countries/regions, institutions, authors and publications, respectively. Then, this paper investigates some deep researches, including the burst detection analysis, co-occurrence analysis and timeline analysis. Finally, combining the analysis results with the current financial environment and the influential event (i.e., COVID-19), this paper further discusses the current challenges and future possible extension trends. Accordingly, a relatively throughout perspective for the FI documents is provided, which will help the scholars interested in this area conduct deep research.

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1. Introduction

The existing definitions of financial innovation (FI) are mainly derived based on the opinion of Joseph Alois Schumpeter, a famous Austrian American economist. In 1912, in his book, *Theory of Economic Development*, he defined innovation that it refers to the establishment of a new production function, that is, a new combination of business elements (Arthur, 2009). Currently, there is no unified definition for FI, mainly classified into three levels: (1) macro-level, connecting with historical changes; (2) meso-level, related to the innovations of technology, product and system; (3) micro-level, about the innovation of financial tools (Bátiz-Lazo & Woldeesenbet, 2006; Iwamura & Jog, 1991; Mention & Torkkeli, 2012; Oke, 2007).

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Since the financial crisis of 2008, the re-evaluation and re-conceptualisation have become a focus (Khraisha & Arthur, 2018). After that, with the increasing complexity of the financial market, the system has taken place great changes by introducing artificial intelligence and constructing digital platforms (Cao et al., 2020; Julian & Peter, 2020; Yu & Shen, 2019). For example, the products have the Internet lending platform (Yu & Shen, 2019; Julian & Peter, 2020), financial digitalisation (Bongomin et al., 2019; Hornuf et al., 2020), blockchain technology (Ye & Chen, 2016), and so on.

However, little work has been done to gather and evaluate the current state of research. It is necessary to comprehensively analyse the characteristics of current publications in the field of FI. Bibliometrics, as a relatively mature and important branch of intelligence science (Borgman & Furner, 2002; Wang et al., 2018), can review the existing papers and analyse the theory and application of FI. Also, it takes all the documents in the field of FI into account, investigates the research hot topics and predicts possible development trends, which has attracted wide attention and has been applied in the research on different journals and fields. For example, the research scopes, development experience and documents of the *European Journal of Operational Research* (Laengle et al., 2017), *IEEE Transaction on Fuzzy Systems* (Yu et al., 2018), *Information Sciences* (Yu et al., 2017) and *Applied Intelligence* (Yu et al., 2019) were presented. In terms of research topics, this method has been widely applied in support vector machines (Yu et al., 2020), fuzzy decision making (Liu & Liao, 2017), business and economics (Merigo et al., 2016), etc.

Considering the advantages and mature technologies of bibliometrics, this paper aggregates all publications obtained in an academic website and analyzes the current foundation features of documents, and then, catches the dynamic trend in different sub-periods. Meanwhile, CiteSpace (Chen, 2006) and Vosviewer (Stopar & Bartol, 2019), as two hot visualisation tools, are selected to visualise the key networks, such as cooperation network of countries/regions, co-occurrence network of author-keywords, co-citation network of journals, burst detection and timeline visualisations, which is also an important process called science mapping analysis.

In summary, our work belongs to review publications related to FI based on some bibliometric indicators. The contributions can be listed as follows:

- (1) General analysis and basic features are provided by illustrating the current status, including the perspectives of types and research directions, and important indicators (i.e., H-index (Hirsch, 2005; Wang et al., 2020; Xu et al., 2019) and citations) at the levels of countries/regions, institutions and journals. Also, the dynamic number of publications and citations are presented from 2001 to 2020;
- (2) Analysing the cooperation relationships at the level of countries/regions and institutions, the corresponding networks are demonstrated;
- (3) The themes of all publications and the top influential journals are aggregated based on the author-keywords analysis aimed to help scholars understand the hotspots and focus;
- (4) Further analyses including the burst detection and timeline processes contribute to scholars grasp the trend of multiple topics and easier to locate the corresponding research;
- (5) According to all the analyses and visualisation mapping, combining with the current environment, the challenges, the extensions and the future possible directions are discussed, mainly involving financial system, operation management and possible areas to extend, etc.

The rest of this paper is organised as follows: Section 2 presents the scope and data source. The foundation characteristics, including types, current research directions and annual publications, productive countries/regions, institutions and journals, are illustrated in Section 3. Section 4 investigates the cooperation relationship among countries/regions, and then provides citation structure analysis of journals and authors. Section 5 analyzes the burst detection of cited journals, cited authors and author-keywords. Also, the timeline analysis of author-keywords is illustrated. Furthermore, the current challenges and future possible research directions are provided in Section 6. Section 7 ends this paper with some conclusions.

2. Scope and data source

Web of Science (WoS) is one of the most widely-used databases in academics, and makes academics have access to obtain leading journals and detailed information of the publications (Falagas et al., 2008). Thus, the literature data used in this paper are from WoS, and the retrieval strategies are as follows: Topic search = 'Financial Innovation'; Timespan= 1900–2020 (The data are derived from WoS on Aug. 20, 2020. We have searched the publications from the earliest time.); Databases = Web of Science™ Core Collection (We collect data related to Science Citation Index Expanded (SCI-E), Social Sciences Citation Index (SSCI), Arts and Humanities Citation Index (A&HCI), Conference Proceedings Citation Index-Science (CPCI-S), Conference Proceedings Citation Index-Social Science and Humanities (CPCI-SSH) and Emerging Sources Citation Index (ESCI)). Then, 1,341 publications are selected in WoS. The publications are exported in the form of text, which contains the title, author, unit, keywords information and citation information, etc.

This paper analyzes the characteristics of the FI publications mainly from two aspects: (1) the foundational features, i.e., the productivity and influence of publications based on certain bibliometric indicators, such as the total number of publications (TP), the total number of citations (TC), the average citations per publications (AC) and H-index from the perspective of countries/regions, institutions, authors; (2) the visual analysis results, that is, this paper uses CiteSpace and Vosviewer to present the visualisation networks, which is helpful to clear the research hotspots and development trend. The process is important and essential. Also, it has been applied in many areas because of the flexible mapping visualisation and powerful user graphic-interface (Chan & Kuehl, 2019; Chen & Liu, 2020; Kamdem et al., 2019; Wang et al., 2019).

3. The foundational characteristic of the FI publications

In this section, the foundational characteristics of the 1,341 publications are analysed from four aspects, including types, research directions and annual publications, productive countries/regions, institutions and journals. The corresponding citation numbers and ranking situations are all presented in the form of tables and figures. Besides, this section also uses certain indicators, such as ≥ 200 and ≥ 100 .

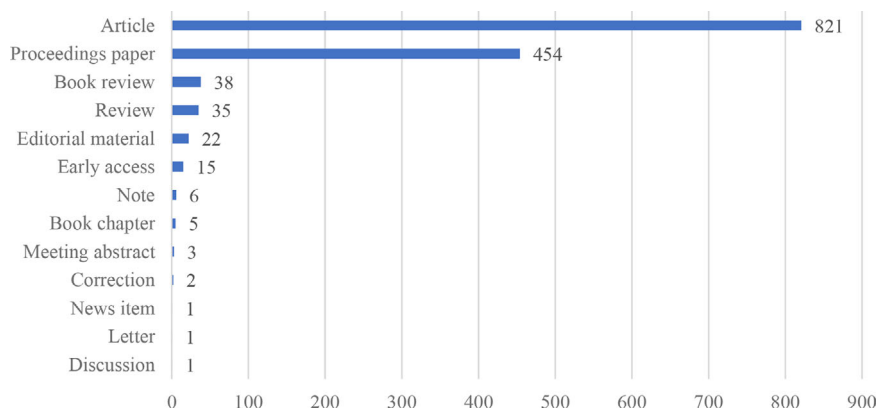


Figure 1. The type distribution of the publications.

Source: generated using WoS on data.

3.1. Types, research directions and annual publications

According to WoS, we obtain all types of FI publications. They are classified into 13 types, as shown in Figure 1.

From Figure 1, we can see that the most type of publications is articles with 821, which occupies 66.223% of all documents. Followed, 454 publications are proceedings papers, accounting for 33.855%; 38 and 35 of them are book review and review, respectively. Besides, there are 22 editorial materials, 15 early accesses, 6 notes, 5 book chapters, 3 meeting abstracts, 2 corrections, 1 discussion, 1 letter and 1 news item. Articles and proceeding papers are the main choices for academics in this field.

Figure 2 presents the top 10 research directions of publications related to FI. The most popular research directions are business economics (978) and social sciences other topics (120), accounting for 81.88% of the total number. They are followed by operations research management science (99), government law (97), computer science (96), engineering (86), public administration (56), mathematical methods in social sciences (50), international relations (35) and education educational research (34). Besides, there are also some directions with more than 10 publications: environmental sciences ecology, mathematics, arts humanities other topics, urban studies, history, development studies, science technology other topics, sociology, telecommunications, area studies, geography and information science library science.

We can see that there are rich research directions and FI has been widely used in many fields. These directions can be classified into macro innovation and micro innovation. In terms of macro innovation, a lot of research outputs are related to the innovations of financial technology, financial market, financial services, product and management methods, etc., such as business economics, social sciences and government law. In terms of micro innovation, the financial tools and models are investigated, related to some directions, such as operational research management science, computer science and engineering.

Figure 3 presents the annual publications and the trendline from 2005 to 2020. There is overall showing an upward trend and the number of publications has three peak periods, i.e., 2009 (78), 2015 (100) and 2019 (103). Investigating the reasons, we

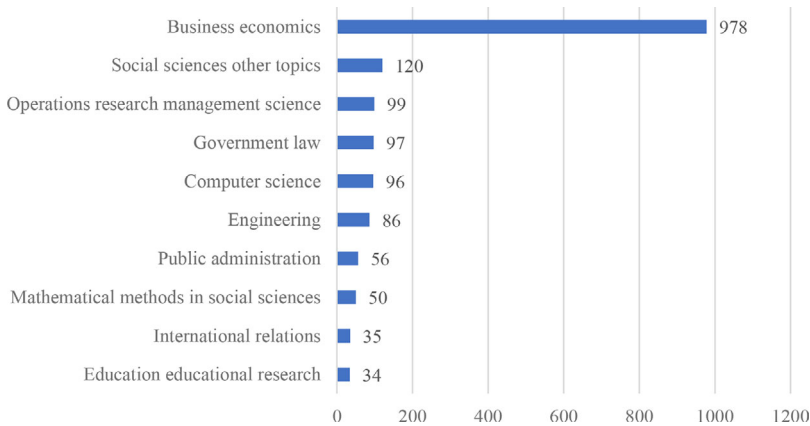


Figure 2. The top 10 research directions of the publications related to FI.
Source: generated using WoS on data.

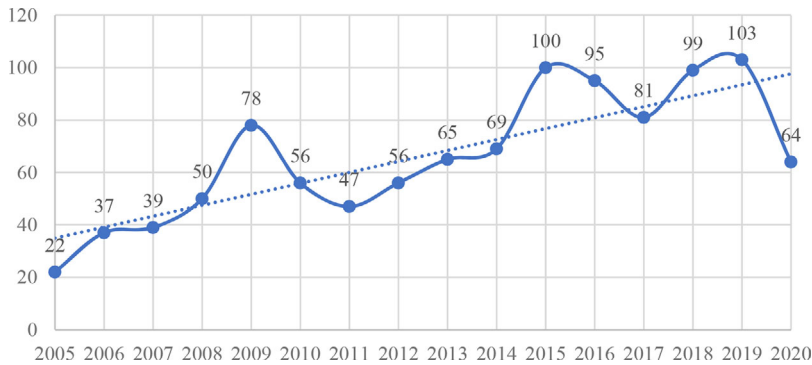


Figure 3. The number of publications and the trendline nearly 15 years.
Source: generated using WoS on data.

have: (1) for 2009, since the financial crisis of 2008, the development of FI has been a focus on re-evaluation and re-conceptualisation; (2) after applying the research results to a series of practical problems, scholars continue to modify the shortcomings of the existing systems, and then a large number of novel theoretical and application documents have been emerged adapted to the increasingly complex financial environment. This phenomenon can be reflected by the number of publications after 2014.

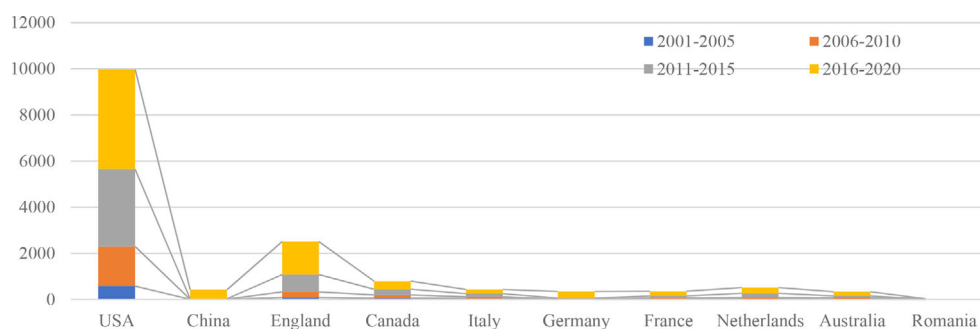
3.2. Productive countries/regions

Regarding one of the important factors, i.e., countries/regions, we obtain the top 10 most productive countries/regions. Also, the total number of publications (TP), the total number of citations (TC), the average citations per publications (AC), the percent of TP for all 1,341 publications (%TP), the number of publications that are cited equal to or more than 500/300/100/50 ($\geq 500/\geq 300/\geq 100/\geq 50$) and H-index are used to demonstrate the citation impact of the productive countries/regions, as shown in Table 1.

Table 1. The top 10 most productive countries/regions.

Rank	Countries/regions	TP	TC	AC	%TP	≥ 500	≥ 300	≥ 100	≥ 50	H-index
1	USA	386	10,557	27.35	28.78%	2	3	19	50	50
2	China	368	418	1.14	27.44%	0	0	1	1	9
3	England	151	2,542	16.83	11.26%	0	0	2	18	26
4	Canada	56	835	14.91	4.18%	0	0	2	4	15
5	Italy	43	448	10.42	3.21%	0	0	0	3	10
6	Germany	43	343	7.98	3.21%	0	0	0	1	11
7	France	42	353	8.4	3.13%	0	0	0	1	11
8	Netherlands	34	526	15.47	2.54%	0	0	0	3	14
9	Australia	33	336	10.18	2.46%	0	0	0	1	11
10	Romania	26	19	0.73	1.94%	0	0	0	0	2

Source: generated using WoS on data.

**Figure 4.** The changes in the citations of the top 10 most productive countries/regions.

Source: generated using WoS on data.

According to Table 1, the USA and China are the most two productive countries with 386 and 368 publications, followed by England (151) and Canada (56). The USA has the greatest number of TC with 10,557, AC with 27.35 and H-index with 50. It is the only country that has two publications with ≥ 500 and three publications with ≥ 300 . China ranks second place on the number of publications, however, in terms of TP and AC, it has more room for development.

To describe the dynamic development of the top 10 most productive countries/regions, we analyse the citation trends from 2001 to 2020. The research period is divided into four sub-periods (2001–2005, 2006–2010, 2011–2015 and 2016–2020). The numbers of citations in the four sub-periods are shown in Figure 4. The number of citations from 2016 to 2020 accounts for the greatest proportion, then the third period. Besides, from 2016 to 2020, the USA and England have the most citations, similarly, for 2010 to 2015. For all periods, the USA always is the leader. With the development, from the perspective of the development trend of China, citations and influence are increasingly upward. The citations of four sub-periods are 0, 6, 21 and 391, respectively. Then, this paper obtains the top 10 most influential publications, as shown in Table 2.

In the top 10 authoritative papers, 8 of them are from the USA, 7 of them are articles. According to the citation, the first place is the work of Laibson, D (1997) published in *Quarterly Journal of Economics*, followed by Campbell, John Y. (2006) and Crotty J. (2009). The article ‘Golden eggs and hyperbolic discounting’ not only has the most citations but also ranks first place in terms of citation/year with 83.83. The paper is to

Table 2. The top 10 most influential publications.

Rank	Title	Author	Year	Citation	Citation/ year	Type	Country/ region
1	Golden eggs and hyperbolic discounting	Laibson, D	1997	2012	83.83	Article	USA
2	Household finance	Campbell, John Y.	2006	665	44.33	Article/proceedings paper	USA
3	Structural causes of the global financial crisis: a critical assessment of the 'new financial architecture'	Crotty, J.	2009	322	26.83	Article	USA
4	The capitalisation of almost everything – The future of finance and capitalism	Leyshon, A.; Thrift, N.	2007	225	16.07	Article/proceedings paper	England
5	Collective risk management in a flight to quality episode	Caballero, Ricardo J.; Krishnamurthy, A.	2008	204	15.69	Article	USA
6	A liquidity-based model of security design	DeMarzo, P; Duffie, D	1999	188	8.55	Article	USA
7	Neglected risks, financial innovation, and financial fragility	Gennaioli, N.; Shleifer, A.; Vishny, R.	2012	168	18.67	Article	USA
8	Financial innovation - the last 20 years and the next	Miller, M. H.	1986	168	4.8	Article	USA
9	Emerging problems with the Basel Capital Accord: Regulatory capital arbitrage and related issues	Jones, D	2000	150	7.14	Article/proceedings paper	USA
10	Cartographies of race and class: Mapping the class-monopoly rents of American subprime mortgage capital	Wyly, E.; Moos, M.; Hammel, D.; Kabahizi, E.	2009	147	12.25	Article	Canada

Source: generated using WoS on data.

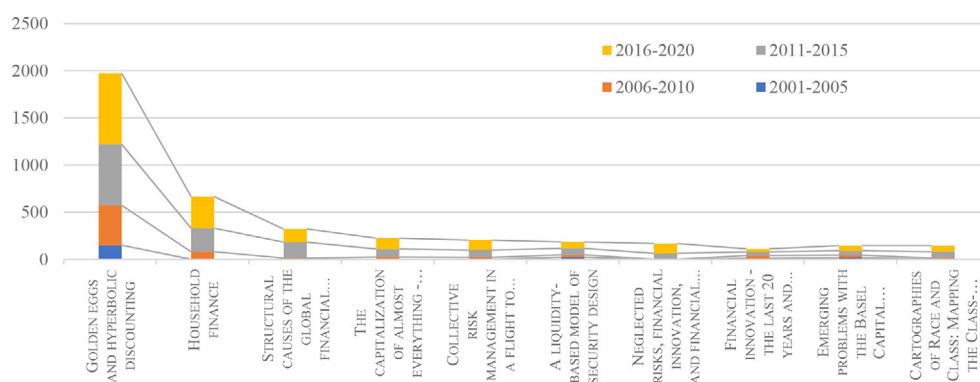


Figure 5. The dynamic number of citations for the top 10 authoritative papers.
Source: generated using WoS on data.

Table 3. The top 10 productive institutions.

Rank	Institution	TP	TC	AC	≥100	≥50	H-index
1	Federal Reserve System USA	40	1,270	31.75	4	10	16
2	University of London	37	757	20.46	2	6	14
3	National Bureau of Economic Research	32	1,813	56.66	4	11	16
4	Wuhan University of Technology	32	26	0.81	0	0	4
5	University of California System	28	580	20.71	1	4	10
6	Harvard University	27	3,620	134.07	6	9	15
7	University of Oxford	17	409	24.06	0	3	9
8	University of Wisconsin System	17	335	19.71	0	2	12

Source: generated using WoS on data.

present a model and analyse a hyperbolic consumer, and then deduces that financial market innovation may reduce welfare by providing ‘too much’ liquidity (Laibon, 1997).

To better describe the dynamic development of the top 10 most influential papers, we develop the citation trend at four sub-periods. The numbers of citations are shown in Figure 5.

From Figure 5, the paper ranked in the first place has been highly influential since 2006, which explains one of the research hotspots in the field of FI. And then, the paper ranked in second place obtains widely attention of scholars from 2011, its studies relate to household finance and argue the investment mistakes in risky asset markets.

3.3. Productive institutions

Table 3 lists the top 8 most productive research institutions in the field of FI all over the world. Even though scholars have started the search in this field early (1963), the publications are not very much. From Table 3, Federal Reserve System USA with 40 publications is at the top of the list, followed by the University of London, National Bureau of Economic Research, Wuhan University of Technology, the University of California System, Harvard University, the University of Oxford and the University of Wisconsin System.

As far as TC is concerned, Harvard University has the greatest number of citations (3,620), even though it is not the most productive institution. The second to eighth institutions are the National Bureau of Economic Research (1,813), Federal Reserve

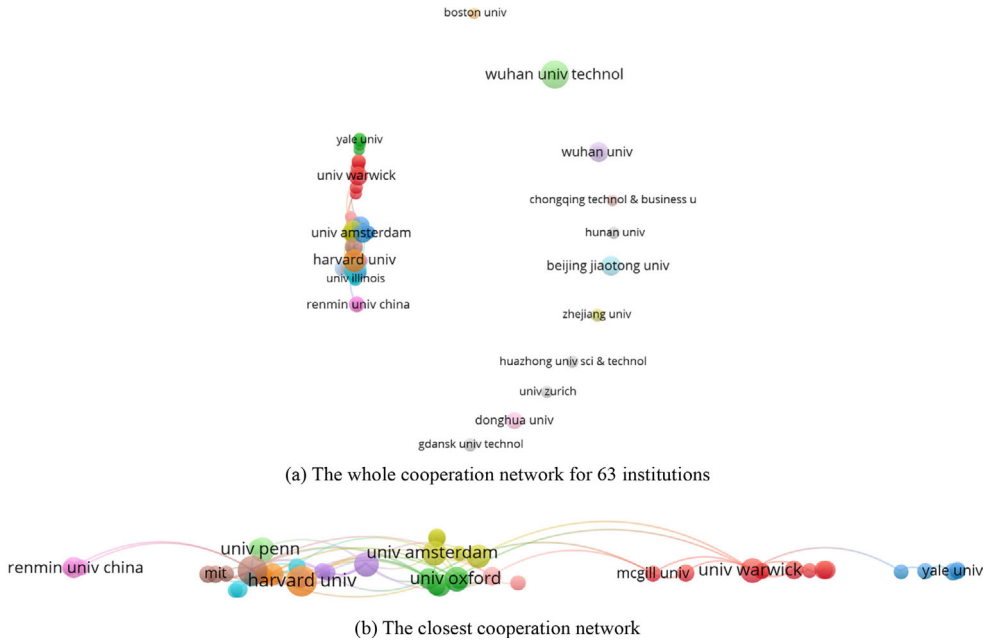


Figure 6. The cooperation network of institutions.

Source: generated using Vosviewer on data.

System USA (1,270), University of London (757), University of California System (580), University of Oxford (409), University of Wisconsin System (335) and Wuhan University of Technology (26). According to AC, Harvard University is still in first place with 134.07. Different from the ranking of TC, the University of Oxford is ranked fourth with 24.06.

Among them, the most cited paper (its frequency is 2,012) is from Harvard University. Also, there exists a cooperation situation among institutions, for example, the paper 'Household financial' with citations 665 is the common achievement of the National Bureau of Economic Research and Harvard University.

Next, the characteristics of cooperation between institutions are investigated. This paper chooses the 63 institutions with the number of documents equal to or more than 5. The whole cooperation network among the 63 institutions and the closest visualisation network of connected institutions consists of 48 by Vosviewer are illustrated in Figure 6.

In Figure 6, the node represents the research institution, the size of the node denotes the number of documents, the connection between two nodes means that there is a cooperative relationship. The thicker of the connection, the more strength of the cooperation. We can obtain that: National Bureau of Economic Research has close cooperation with other institutions, its total link strength is 31 and the documents related to cooperation are 19 with citations 1,546; it is followed that the total link strength of the Centre for Economic Policy Research is 17 related to 10 documents with citations 304; Harvard University is ranked at the third place in terms of cooperation degree with total link strength 13 related to 20 documents and citations 1,279. Besides, there are some institutions not participating in the cooperation, such as the Wuhan University of Technology and Beijing Jiaotong University.

3.4. Productive journals

This paper studies the journal of all FI publications. According to WoS, 836 journals have published the papers on the FI theme. The distribution of these publications is centralised, the journals with equal to or more than 10 publications are occupied 12.369% of all 1,341 documents.

Table 4 lists the names, citations and other important information of the top 11 productive journals. *Journal of Banking Finance* (27) and the *Journal of Financial Economics* (19) are the top 2 most popular journals for scholars in the field of FI. *Review of Financial Studies*, *Applied Economics* and *Journal of Finance* rank the third to the fifth. 6 of them have Impact Factor (IF) more than 2. *Journal of Finance* is the journal with the highest IF (6.813), followed by the *Journal of Financial Economics* (5.731) and *Review of Financial Studies* (4.649). Besides, the *Journal of Finance* has the greatest citations (1,104) and is the only journal with more than 1,000 citations.

Also, 4 of them, i.e., *Journal of Banking Finance*, *Journal of Financial Economics*, *Review of Financial Studies* and *Journal of Economic Theory* have published papers with more than 300 citations until now. Due to the different numbers of publications and citations, the rankings of AC are also different. For example, for the *Review of Financial Studies* and *Journal of Economic Theory*, the former has a higher number of TC (461), the latter has great AC (32.33). Some other important indicators are also presented to illustrate them, such as ≥ 100 , the most cited articles and their cited times.

In order to illustrate the research focuses of the FI field and help scholars to understand the research topics, Figure 7 presents the author-keywords of all 1,341 documents and the 4 influential journals (in terms of TP and IF, we select *Journal of Banking Finance*, *Journal of Financial Economics*, *Review of Financial Studies* and *Journal of Finance*), which do not include the general keyword, i.e., financial innovation.

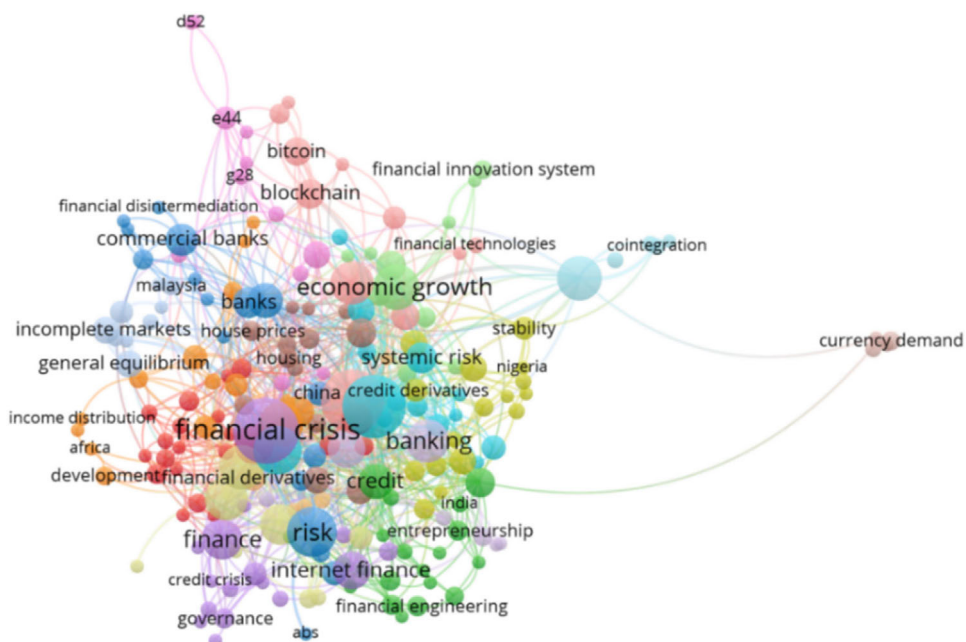
In Figure 7, the nodes denote the author-keywords and the sizes of the nodes mean the numbers of occurrences. The link between the two keywords indicates that they appear in the same paper at the same time. Table 5 presents the frequencies of the top 20 author-keywords.

From Figure 7 and Table 5, the most frequent keyword is 'financial crisis' with 42 and 3. There are 65 documents related to this topic, 2009 is the most productive year and the most cited paper is *Structural causes of the global financial crisis: a critical assessment of the 'new financial architecture'* with 322 citations. It discussed the structural flaws of the financial system and the prospects for financial reform (Crotty, 2009). The phenomenon explains that, after the financial crisis, re-evaluating and reassessing the characteristics of the system is one of the important research points for scholars. Besides, the keyword 'risk' (26) also reacts to this point. Another high-frequency keyword 'securitisation' has the number of citations 25 and 3, related to 76 documents. The most cited publication is *The capitalisation of almost everything - The future of finance and capitalism* with 225 citations (Leyshon & Thrift, 2007). It expanded the financial value chain. The analyses of author-keywords help scholars to locate the research focuses and appropriate journals.

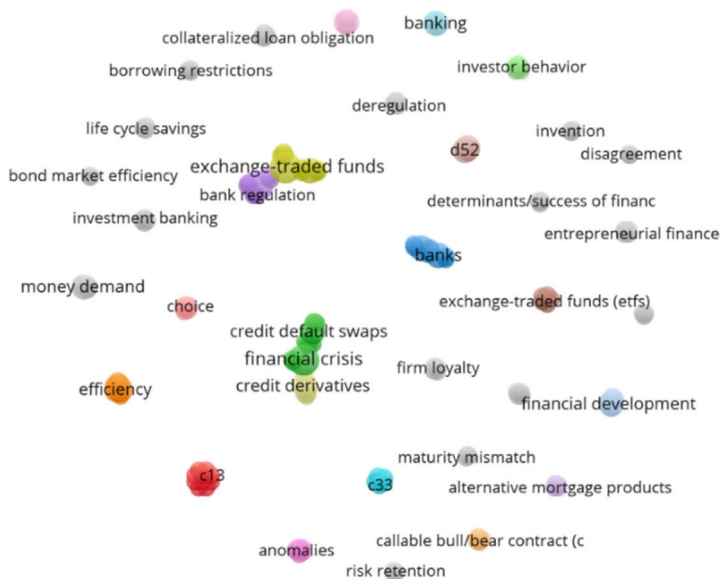
Table 4. The top 10 productive journals.

Rank	Journals	IF (2019)	IF (5 years)	TP	TC	%TP	AC	≥100	≥50	The most cited articles	Time cited
1	<i>Journal of Banking Finance</i>	2.269	3.377	27	812	2.012	30.07	3	5	Jones, D. (2000)	150
2	<i>Journal of Financial Economics</i>	5.731	8.804	19	899	1.416	47.32	4	7	Gennaioli, N. et al. (2012)	169
3	<i>Review of Financial Studies</i>	4.649	7.1	16	461	1.192	28.81	1	2	Liu, J and Longstaff, F. A. (2004)	80
4	<i>Applied Economics</i>	1.103	1.178	15	213	1.118	14.2	0	1	Bahmani-Oskooee, M. and Rehman, H. (2005)	59
5	<i>Journal of Finance</i>	6.813	9.738	15	1,104	1.118	73.6	2	4	Campbell, John Y. (2006)	665
6	<i>Economic Theory</i>	1.051	1.036	14	154	1.043	11	0	1	Cass, D. and Citanna, A.	57
7	<i>Journal of Economic Issues</i>	0.577	0.795	14	75	1.043	5.36	0	0	Carter, M. (1989)	13
8	<i>Journal of Money Credit and Banking</i>	1.455	2.356	14	190	1.043	13.57	0	1	Alam, IMS (2001)	60
9	<i>Journal of Economic Theory</i>	1.124	1.588	12	388	0.894	32.33	1	3	Detemple, J. and Murthy, S. (1994)	120
10	<i>Economic Journal</i>	2.764	4.086	10	53	0.745	5.3	0	0	Cai, P. et al. (2008)	19
11	<i>Financial Innovation</i>	2.964	-	10	157	0.745	15.7	1	1	Guo, Y. and Liang, C. (2016)	103

Source: generated using WoS on data.



(a) the co-occurrence network for all keywords



(b) the co-occurrence network for 4 influential journals

Figure 7. The co-occurrence networks of author-keywords.
Source: generated using Vosviewer on data.

Table 5. The top 20 most frequent keywords.

All journals		The selected 4 influential journals	
Keywords	Freq	Keywords	Freq
Financial crisis	42	Exchange-traded funds	3
Innovation	39	Financial crisis	3
Risk	26	Securitisation	3
Securitisation	25	banking	2
Economic growth	23	Banks	2
Financial regulation	22	Credit default swaps	2
Money demand	21	Credit derivatives	2
Regulation	21	d52	2
Banking	20	Efficiency	2
Fintech	20	Financial development	2
Shadow banking	20	G12	2
Finance	18	Liquidity	2
Risk management	18	Money demand	2
Derivatives	17	Productivity	2
Financialization	16	Risk management	2
Internet finance	16	Structured products	2
Credit	14	Alternative mortgage products	1
Liquidity	14	Anomalies	1
Commercial banks	13	Asymmetric information	1
Banks	12	Bank holding companies	1

Source: generated using Vosviewer on data.

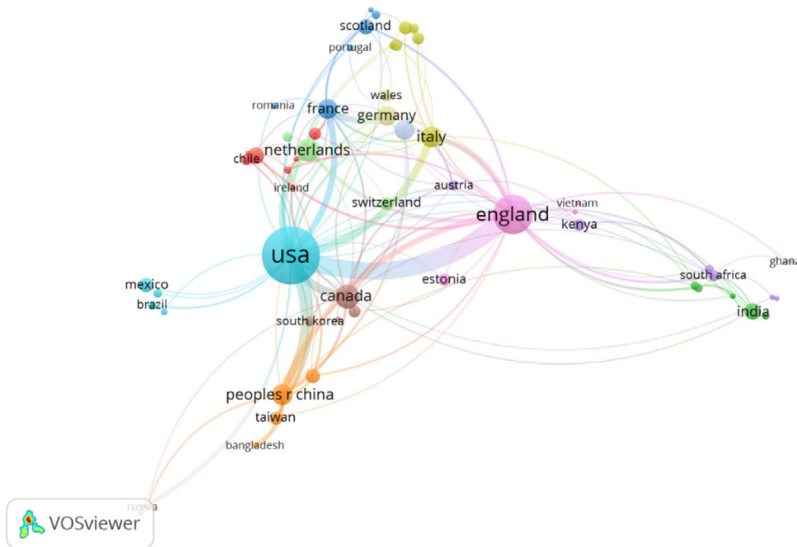


Figure 8. The collaboration network of country/region.

Source: generated using Vosviewer on data.

4. Cooperation networks and citation structure analysis

Subsection 3.3 explains the importance of the cooperation relationship, this section investigates the cooperation situation of countries/regions and the citation structure of journals and authors further.

The 1,341 publications are related to 82 countries/regions, Figure 8 demonstrates the closest cooperation network including 61 countries/regions. The nodes denote

Table 6. The top 10 cited counties/regions in the country collaboration network.

Rank	Country/region	P	TC	C	Links	Total link strength	Cluster
1	USA	327	10,557	7,372	34	117	6
2	England	131	2,542	2,432	28	87	9
3	Canada	48	835	591	16	35	8
4	Netherlands	34	526	526	12	29	11
5	Italy	41	448	446	7	22	4
6	China	368	418	418	11	47	7
7	France	42	353	353	15	36	3
8	Germany	41	343	343	16	31	13
9	Australia	32	336	335	10	20	12
10	India	16	218	227	9	10	2

Source: generated using Vosviewer on data.

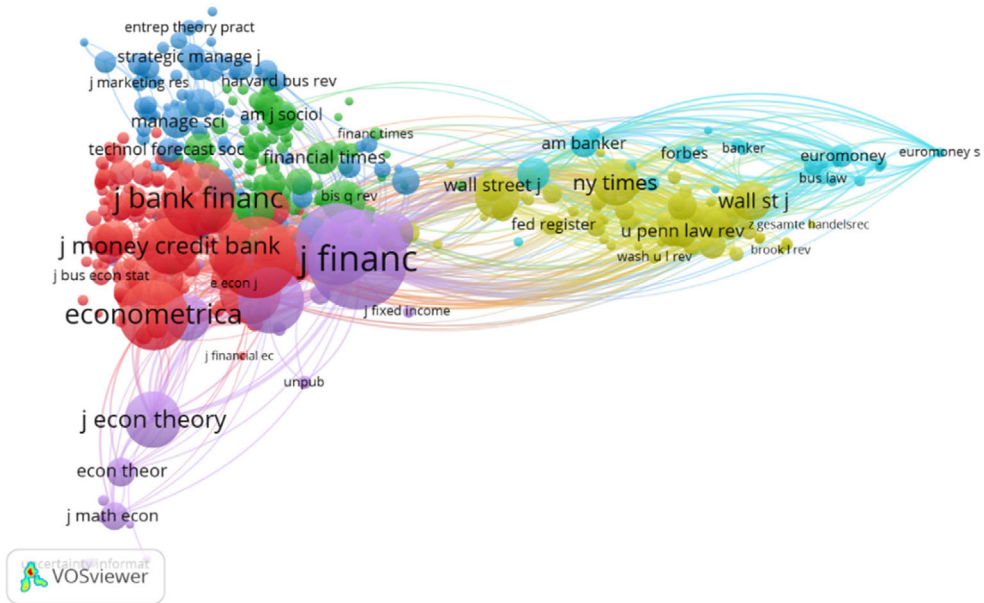


Figure 9. The co-citation network of journals.

Source: generated using Vosviewer on data.

countries/regions, the sizes of the nodes mean the numbers of citations. The 61 countries/regions are classified into 14 clusters, the most cooperative countries/regions are the USA, England, China, Canada, France and Italy, etc. Additionally, the connections between two countries/regions represent the degree of cooperation, the thicker the connection, the closer the cooperation. As a result, the USA is the most cooperative, and often cooperates with England, China and Canada. Specifically, the indicators, i.e., P, TC, C (here, P and C denote the citations of cooperation), links (the number of cooperating countries/regions with the target one), total links strength (the weight of links) and cluster, are used to describe cooperation countries/regions, as shown in Table 6.

In Table 6, China has the most publications (368) related to cooperation with others. The USA has the most TC (7,372) related to 327 documents, its total link strength is also the greatest (117), which belongs to the cluster 6. It is followed that

England ranks second place in terms of TC (the number of TC is 2,432), involving 131 publications and belonging to the cluster 9. For Netherlands and Italy, even the total link strengths only 29 and 22, respectively, they have great C, ranked at fourth and fifth. Then, the seventh to tenth are France, Germany, Australia and India. In summary, the collaboration helps improve the influence and the quality of publications.

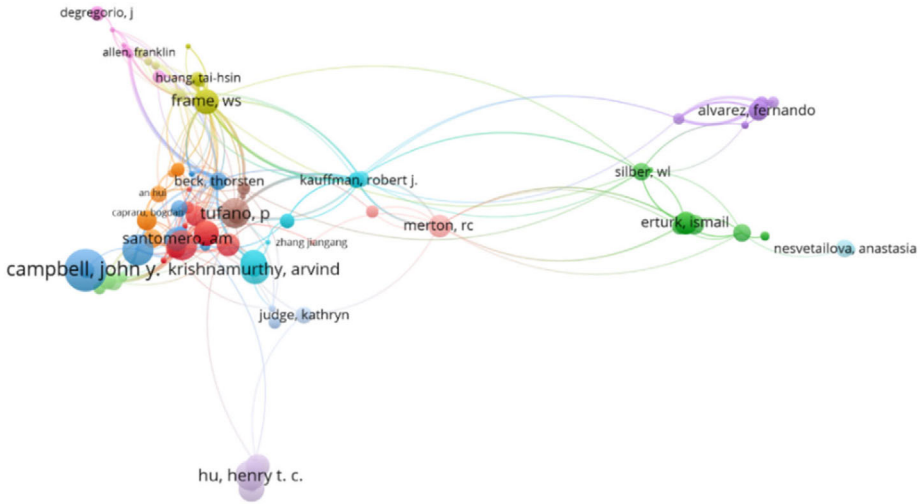
Furthermore, we study the citation structure of journals. [Figure 9](#) presents the co-citation network of journals by setting the minimum number of citations of a journal to 10. There are 508 journals in the network. The node and its size denote the journal and the number of citations, respectively. The link represents that the linked two journals are cited in the same paper at the same time. For more details, the *Journal of Finance* has the greatest citation (its citation is 1,231), and it is the most influential journal (its IF is 6.813 and TC is 1,104) in the top 10 most productive journals (see [Table 4](#)). Followed, the second to tenth journals are *American Economic Review* (830), *Journal of Finance and Economics* (819), *Journal of Banking & Finance* (679), *Econometrica* (611), *Review of Financial Studies* (538), *Journal of Political Economy* (469), *Quarterly Journal of Economics* (466), *Journal of Economic Theory* (407) and *Journal of Money Credit and Banking* (404).

In terms of cited authors and co-cited authors, the former explains the number of times that the author has been cited. The latter reflects that two authors are cited in one paper at the same time. The two methods contribute to knowing the influential authors in the field of FI. [Figure 10](#) illustrates the citation and co-citation network by setting the minimum number of documents of an author to 2 and the minimum number of citations of an author to 20. Then, we obtain 123 closest cited authors from 2,239 and 162 co-cited authors from all 23,824, respectively. According to Vosviewer, the 123 cited authors are classified into 15 clusters with different colours. Each node denotes an author, the size of the node means the number of citations. The greater the node, the more times the author is cited by the 1,341 papers. The 162 co-cited authors are classified into 6 clusters. The connections between the two authors indicate that they appear in one paper at the same time. The thicker the line, the more often the two authors appear together. Correspondingly, some indicators, such as C, links and total link strength, are also listed in [Table 7](#).

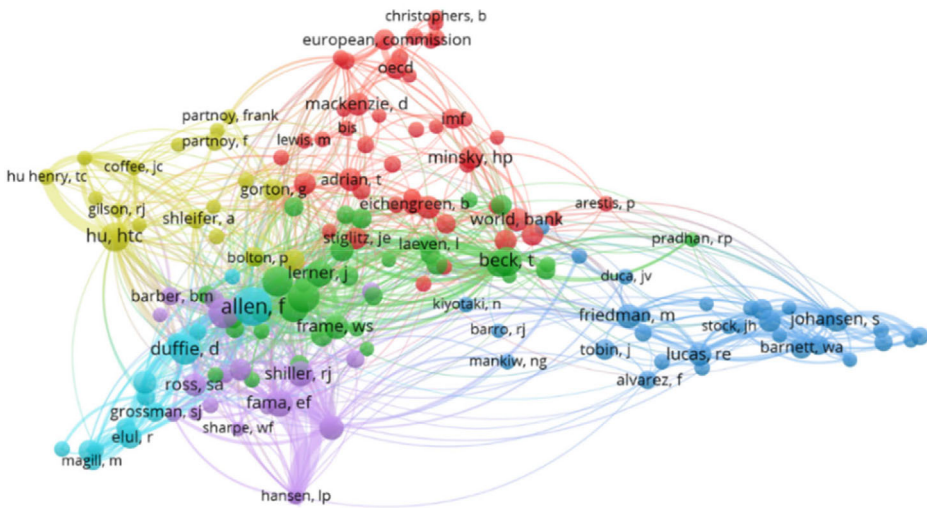
It is noted that the most cited paper with 2,012 citations (see [Table 2](#)) is not included because Laibson D only has published one document in the field of FI. Similarly, there is an author, called Crotty James, who also does not appear in [Table 7-1](#) with only one FI publication with 322 citations. For the authors who published more than 2 papers, Campbell, John Y. is the most influential with 2 publications and 675 citations, which is obvious in [Figure 10\(a\)](#). Followed by Allen F., also, he/she is ranked first place in the co-citation network (the number of citations is 247). 145 authors have been cited with him/her.

5. Deep analysis of FI

To analyse information deeply for FI publications, this section conducts some in-depth studies to explore potential feature from multiple aspects, including burst



(a) The citation network of authors



(b) The co-citation network of authors

Figure 10. The network of the influential authors.
Source: generated using Vosviewer on data.

detection analysis in terms of authors and journals, and the timeline analysis of author-keywords. To improve reference value, this section extracts the documents published in the past 20 years, i.e., from 2001 to 2020

5.1. Author and journal burst detection analysis

Citation burst detection reflects the explosive data that obtain attention in a certain period (Kleinberg, 2003). Thus, it can reflect the dynamic development from various

Table 7-1. The top 10 cited authors in the citation network of authors.

Rank	Author	P	C	Links	Total link strength	Cluster
1	Campbell, John Y.	2	675	1	1	3
2	Allen, F.	3	317	12	19	3
3	Hu, Henry T. C.	8	283	4	25	14
4	Duffie, D.	2	273	29	42	1
5	Tufano, P.	3	273	26	36	8
6	Krishnamurthy, A.	2	264	3	3	6
7	Gennaioli, N.	2	203	8	12	6
8	Shleifer, A.	2	203	8	12	6
9	Black, B.	2	190	2	13	14
10	Frame, W.S.	2	180	33	47	4

Source: generated using Vosviewer on data.

Table 7-2. The top 10 cited authors in the co-citation network of authors.

Rank	Author	C	Links	Total link strength	Cluster
1	Allen, F.	247	145	2,693	6
2	Tufano, P.	148	139	1,818	2
3	Berger, A.N.	134	100	1,146	2
4	Duffie, D.	130	123	1,410	6
5	Merton, R.C.	122	135	1,436	5
6	Hu, HTC.	119	98	1,448	4
7	Miller, M.H.	119	145	1,415	2
8	Beck, T.	110	117	1,336	2
9	Levine, R.	101	116	1,321	2
10	Fama, E.F.	93	116	1,916	5

Source: generated using Vosviewer on data.

Table 8. The top 10 cited authors with the strongest citation bursts from 2001 to 2020.

Rank	Cited authors	Strength	Begin	End	2001–2020
1	Beck T.	11.7413	2018	2020	
2	Elul R.	9.6362	2001	2009	
3	Cass D.	8.7828	2001	2009	
4	Rajan R.G.	8.5487	2012	2016	
5	Duffie D.	8.5365	2001	2009	
6	Hart O.D.	7.7669	2001	2007	
7	King R.G.	7.1336	2018	2020	
8	Lerner J.	6.9321	2012	2015	
9	Frame W.S.	6.7669	2014	2015	
10	Levine R.	6.2936	2017	2020	

Source: generated using CiteSpace on data.

perspectives. Table 8 lists the top 10 cited authors with the strongest citation bursts. Beck T, as a cited author, has the maximum strength (11.7413). Elul R, Cass D and Duffe D own the longest citation burst detection with 8 years from 2001 to 2009. Besides, Beck T, King RG and Levine R are the closest to the present in Table 8.

Table 9. The top 10 cited journals with the strongest citation bursts from 2001 to 2020.

Rank	Cited journals	Strength	Begin	End	2001–2020
1	<i>Journal of Economic Theory</i>	15.4997	2001	2009	
2	<i>Thesis</i>	14.8707	2018	2020	
3	<i>Journal of Econometrics</i>	14.0854	2017	2020	
4	<i>Economic Theory</i>	12.6832	2001	2009	
5	<i>Working Paper</i>	10.4454	2013	2017	
6	<i>Applied Economics</i>	9.9439	2017	2018	
7	<i>Economic Modelling</i>	9.1428	2018	2020	
8	<i>Journal of Mathematical Economics</i>	8.8009	2001	2005	
9	<i>European Economic Review</i>	8.3337	2002	2011	
10	<i>The New York Times</i>	8.0667	2013	2015	

Source: generated using CiteSpace on data.

Table 10. The top 10 keywords with the strongest citation bursts from 2001 to 2020.

Rank	Keywords	Strength	Begin	End	2001–2020
1	Liquidity	7.8567	2015	2017	
2	Economic growth	7.8482	2017	2020	
3	Financial crisis	6.7489	2009	2015	
4	Economy	6.6969	2001	2008	
5	Growth	6.2418	2018	2020	
6	Incomplete market	5.967	2016	2020	
7	Credit	5.8242	2001	2009	
8	Securitisation	5.7424	2017	2020	
9	Equilibrium	5.4845	2013	2016	
10	Debt	5.246	2001	2008	

Source: generated using CiteSpace on data.

Table 9 presents the top 10 cited journals with the strongest citation bursts by selecting the top 10 levels of most cited or occurred items from each slice. The strength of the *Journal of Economic Theory* is the strongest with the value of 15.4997, which lasted 9 years. This journal publishes original research on economic theory. It is one of nine core journals in all of economics. The themes relate to mechanism design, information, finance, matching, decision theory, game theory, political economy, market design, macroeconomics and monetary economics. The citation burst of the cited journal of *Thesis* is 14.8707 ranked second place with 3 years from 2018 to 2020. The journal of *European Economic Review* has the longest duration with 10 years from 2002 to 2011. The strongest citation bursts of three cited journals have

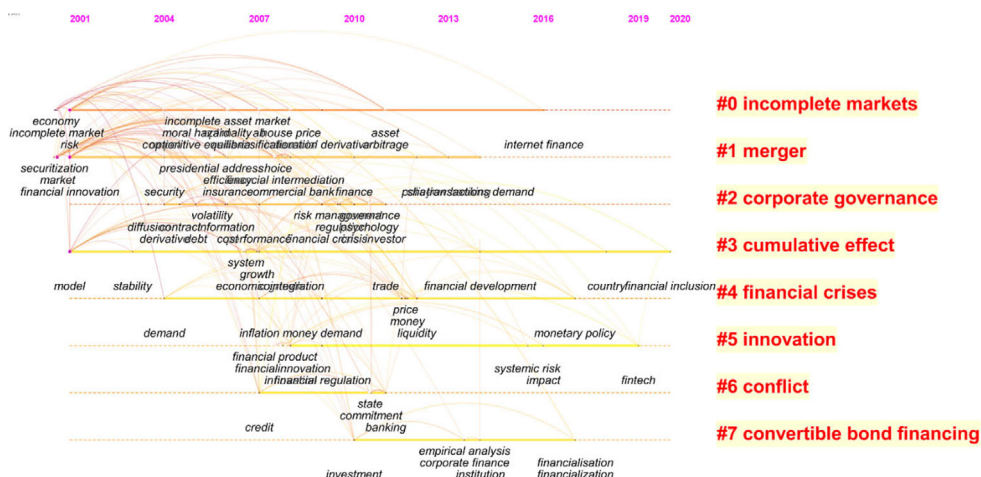


Figure 11. The timeline view of FI publications from 2001 to 2020.
Source: generated using CiteSpace on data.

continued to 2020, i.e., *Thesis, Journal of Econometrics* and *Economic Modelling*, indicating that they still have an impact on FI.

5.2. The timeline analysis of keywords

Section 3 has initially analysed the characteristics of author-keywords and presents the frequencies of them. Further, to better understand the trend of hot topics in the field of FI, this section selects the top 10 levels of most cited or occurred items from each slice, and then lists the top 10 keywords with the strongest citation bursts from 2001 to 2020, as shown in Table 10. ‘Liquidity’ has the strongest citation burst with 7.8564 from 2015 to 2017. ‘Incomplete market’ has the longest duration, lasted 8 years, followed by ‘economy’ (the strength is 6.6969) and ‘equilibrium’ (5.4845). ‘Economic growth’ and ‘credit’, which lasted 4 years, have continued to present.

Besides, all keywords can be classified into 8 clusters, i.e., incomplete markets, merger, corporate governance, cumulative effect, financial crises, innovation, conflict and convertible bond financing. Figure 11 illustrates the dynamic development of the 8 categories of keywords. In this view, the biggest cluster is ‘incomplete markets’, then ‘merger’ and ‘corporate governance’. The cluster ‘cumulative effect’ has the longest duration. Next, ‘financial crises’ is the fifth biggest cluster, lasting from 2004 to 2016. It is also the most frequent keyword for all journals as presented in Table 5. Due to the global financial crisis from 2007 to 2009, lots of publications on this theme have emerged, which explains that changes in the financial market will have a greater impact on the academic community and promote the development and innovation of financial theory and applications. It is one of the important hotspots in the field of FI.

From Figure 11, we also deduce that: scholars focus more on the keywords including incomplete market, risk, securitisation and model, etc., from 2001 to 2004; then, the incomplete asset market, insurance, security, volatility and stability occur most from 2004 to 2007; many new research topics broke out by 2010, such as system,

financial intermediation, financial product, financial regulation, risk management and bank finance, etc.; besides, scholars introduced psychology into FI field in 2010; some topics last until recent years, for example, incomplete market, banking, securitisation and financial regulation. Also, with the development of the market, there are some new research topics in 2020, i.e., financial inclusion.

6. Discussions

Based on the above analysis of FI, we present some current challenges and future possible research directions. From the annual publications and the trendline, we can see that the number of documents has increased significantly after 2008. Combining with the popular keywords in Table 5, the frequency of the keyword financial crisis ranks in the first place. The keywords, including financial regulation and regulation, are related to another hot topic. It can be explained that, affected by the financial crisis of 2008, the re-evaluation and re-conceptualisation processes have been attracted great attention. That is the post-crisis regulation (Bratton & Levitin, 2020). On the other hand, with the advancement of science and technology, the market also has undergone tremendous changes based on various scientific and technological tools such as big data, cloud computing and artificial intelligence (Gai et al., 2016). Accordingly, two new research fields called financial technology (FinTech, it ranks the tenth place in the top 20 most frequent keywords, meanwhile, it is a hot topic in the cluster #6 of the timeline view in Figure 11) and regulatory technology (RegTech, two of the top 20 most frequent keywords are related to it) have emerged to innovate the financial products and services. For example, FinTech start-ups provide better and safer services (Lee & Shin, 2018; Yu et al., 2017). Furthermore, as two topics that have a relatively high degree of attention in the past 4 years and are expected to be further studied in-depth (from the top 10 keywords with the strongest citation bursts from 2001 to 2020), credit and economic growth are widely concerned. Also, the former has a positive bidirectional relationship with the latter under a stable regulatory environment played by financial innovation (Zhou & Dev, 2020).

Accordingly, we cannot neglect the possible impact of COVID-19 on the financial market and the challenges it brings. To fight COVID-19, some financial institutions have presented some measures, such as donating, offering preferential interest rates and increasing online operating channels, which are very important for stabilising production and ensuring that the economy does not suffer a major decline. However, they are also affected by COVID-19 and face the following possible challenges: (1) on online operations: Due to being unable to work normally, some financial institutions have promoted online operations. However, for the businesses that are usually performed offline, if they are switched to online, the operational pressure will suddenly increase. Or, they cannot be transformed into online operations, which causes bottleneck; (2) on the business of financial institutions: The limitation of digital taxation platform is exposed, especially, the online consulting capabilities for taxation agencies' taxation services; (3) the risk of information security will raise; (4) in terms of sales: For insurance, some companies have expanded the product insurance coverage, including COVID-19 and donating insurance to medical staff in Hubei. Thus, the

income decreases and the compensation increases. On the other hand, after COVID-19, the safety awareness of people will improve, the demand for insurance products may increase, which will bring new opportunities; (5) for the perspective of staff management: During the epidemic, companies apply remote office mode, which brings a great impact on employee productivity. In summary, the challenges for the financial market mainly reflect in online operations, digital economy, financial regulation and risk management, etc. Combining the analysis results with the challenges considered above, the possible research directions can be presented as follows: improve the flexibility and efficiency of the digital financial platform; ensure data security and strengthen the risk management level; realise tax automation; realise the integration with advanced technologies; combine the results of multiple fields and multiple disciplines, specifically, the uncertainty decision-making theory under the increasing complexity of the financial market. In this way, the speeds of the innovations in the field of the financial market can adapt to the progress of the times and promote the development of multiple fields, such as financial decision-making and risk assessment. Moreover, there are many other challenges and research directions in FI. The bibliometric analysis can help scholars grasp hot topics and predict trends by continuously adding new research results.

7. Conclusions

In this paper, we have presented a comprehensive analysis and relatively all-around overview of the publications in the field of FI up to 2020. The first document is published in 1963. The average number of papers published annually is 23. The value is low due to the few papers published before 2005. Affected by the financial crisis of 2008, an amount of papers has emerged involving theoretical aspects and applications, which presents a reference to this paper. Meanwhile, it inspires us to analyse the impact of the current financial environment and other influential events (such as COVID-19) on FI. The results of this paper can be summarised below:

It is found that the number of publications has three peaks, distributed in 2009, 2015 and 2019, respectively. The phenomena explain that scholars have a new look at the loopholes in the financial market inspired by the financial crisis of 2008. Through analysing challenges and opportunities, re-evaluating and reform innovation are conducted. Then, injecting new elements into the market aims to find the new development direction.

FI has got involved in lots of fields and has been enriched by many research directions, such as business economic and social sciences. These research topics and keywords mainly concentrate on the financial crisis, banking, financial system, etc. These studies involve all over the world, the USA dominates, followed by China. Considering the number of publications in Taiwan (as a region), China is at a leading level. For the citations, the USA has the greatest number. With the development of the market and baptism through COVID-19, China is expected to catch up with it, which can be reflected in the number of documents (see [Table 1](#)) and citations trend (see [Figure 4](#)).

Next, from the top 10 influential papers, the main research themes are clear, such as consumer behaviour analysis and household finance. The influence of the former continues to grow (see Figure 5). Also, the researches published in different institutions and journals all highlight the current research hotspots in this field. On the other hand, in this paper, we can see that cooperation is another important factor affecting the output of achievements in this field. Absorbing the understanding of innovations from experts in different areas achieves the improvement of multiple industries.

Furthermore, from the burst detection analysis and a timeline view of author-keywords, we are constantly reminded of the impact of the financial crisis on FI, which makes it impossible for us to ignore the impact of COVID-19. Thus, the current challenges and opportunities, the possible extension in the future, are all according to the influence and promotion of the epidemic.

In general, the findings in this paper play a key role in that the scholars who are interested in FI conduct further studies. However, since the data presented in this paper are limited to the WoS score database, as well as setting the searching keyword maybe not comprehensive, the content may need to be enriched in the future. Combining with COVID-19, FI will continuously be injected with new findings to improve the current loopholes and shortcomings. We will collect the productions and pay more attention to the reform.

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