Bibliometric analysis for economy in COVID-19 pandemic

Meihui Zhong **, Mingwei Lin *

College of Computer and Cyber Security, Fujian Normal University, Fuzhou, Fujian 350117, China

ARTICLE INFO

Keywords:
COVID-19
Economy
Bibliometric analysis
Content analysis

ABSTRACT

Since the outbreak of COVID-19, various fields have been damaged to varying degrees, especially in the economic field. According to a comprehensive study of bibliometrics and content analysis, this paper aims at summarizing studies related to the development of the economic field during the COVID-19 epidemic. We search in Web of Science Core Collection using the subjects such as “economics”, “economy”, “economic”, “financial”, and then 2274 related documents are collected, which are published from 2020 to 2022. First, this paper uses the mixed qualitative and quantitative analysis methods to analyze the publication status of the countries, institutions, and authors, respectively, and conducts the document co-citation analysis by CiteSpace software. The results showed that the most popular journal is Sustainability, and the most productive research institutions, countries, and authors are primarily located in North American and European countries. Then, it makes an in-depth study of the cooperative network. With the support of Gephi software, this paper employs the social network analysis method to analyze the situation of the country/region cooperation and institutional cooperation. Finally, the content analysis of the related studies is presented to further explore the current challenges. On this basis, this paper analyzes the economic development in the post-epidemic era and draws some conclusions, which provide some references for scholars interested in this field.

1. Introduction

In December 2019, the emergence of a novel coronavirus led to an increasing number of confirmed cases in the world, which poses a major threat to global public health security. On March 11, 2020, World Health Organization (WHO) listed pneumonia, which was caused by the novel coronavirus (hereinafter referred to as COVID-19), as a global pandemic. According to the statistics reported by authoritative organizations, WHO, and official reports from various countries, there exist more than 50 million confirmed cases up to now. The global distribution of confirmed COVID-19 cases is shown in Figure 1. The Chinese government quickly adopted a series of epidemic prevention measures and controlled the epidemic effectively in March 2020. However, the global epidemic has ushered in the second major outbreak. To control the epidemic as soon as possible, scientific research staffs in various fields around the world engaged in related research work actively and carried out a series of studies on COVID-19 from the aspects of virus source, epidemic characteristics analysis, preventive medicine, prevention and control measures, public health, etc. It can be known that most of these studies mainly focus on Medicine General Internal, Public Environmental Occupational Health, Infectious Diseases, Immunology, and other disciplines. Yarovaya et al. (2022) put forward the information transmission mechanism during the COVID-19 pandemic. To this end, at this stage, we should focus on the trend analysis at the economic level.

Because of the economy of various countries, which have been affected by COVID-19 to varying degrees, there have been many studies on the economy in recent years. For example, in view of the impact of COVID-19 on the economy, some scholars have pointed out that the rapid spread of COVID-19 epidemic has caused a great impact on the global financial market, brought unprecedented risks to the global economy, and caused heavy losses to investors in a short time. The economy has been hit harder, especially in developing countries (Mou, 2020). Furthermore, it is reported that the main economic impact of the COVID-19 epidemic does not come from death, disease, and the time of taking care of patients, but fear, shame, and discrimination, which are the main driving forces affecting the economy (Gong et al., 2020a). In contrast, the food sector and medical sector are facing demand pressure due to panic buying and a shortage of medical supplies (Nicola et al., 2020). Some studies have shown that COVID-19 has caused supply chain disruption. Although the governments of countries are formulating a

* Corresponding author.
** Corresponding author.
E-mail addresses: mhzhong2021@163.com (M. Zhong), linmwcs@163.com (M. Lin).

https://doi.org/10.1016/j.heliyon.2022.e10757
Received 15 May 2022; Received in revised form 6 July 2022; Accepted 20 September 2022
2405-8440/© 2022 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
series of policies to improve supply chain performance, it seems that they have not managed their limited resources fully to ensure a sufficient supply of necessities and to reduce the negative impact of the global financial crisis (Goel et al., 2021).

Since COVID-19 reached its peak, economic anxiety has been on the rise all over the world, and studies have shown that economic anxiety can lead to serious psychological and physical health problems, which should be paid attention to by clinical professionals and policymakers (Bareket-Bojmel et al., 2020). Asia, Europe, and the United States are the most seriously affected areas. Then the whole world economy has been indirectly affected due to the transmission feature of international supply chains. There have been significant losses in valuation in all industries. In extreme cases, ordinary companies in some industries may lose up to 60% of their intrinsic value in one year (Rizvi et al., 2022). It is worth mentioning that transportation and tourism are directly affected industries. COVID-19 poses a challenge to all humans without distinction. The recovery of the world economy after the COVID-19 pandemic depends on the human response to the crisis (Lenzen et al., 2020).

Countries have adjusted the current economic situation, but unconventional policy interventions, such as unlimited quantitative easing (QE) in the United States, will plunge the country into further financial uncertainty and may lead to long-term problems (Zhang et al., 2020). The non-bank, market-based finance, including asset management companies, money market funds, investment funds, and hedge funds, accounts for an increasing proportion of global assets, which seems to be accelerating and amplifying the pressure and instability in the financial system. They have become the next area to be considered in dealing with financial crises (Giese and Haldane, 2020). However, in developing countries, private investment is extremely important because the government does not have enough funds to accept investment projects (Wei et al., 2021). The corresponding emergence of the network economy, which separates the financial economy from the real economy, has led to a gradual increase in the risk of the real economy (Gou et al., 2021). And the risk is increasing dramatically during the epidemic.

McKee and Stuckler (2020) pointed out that if the world fails to protect the economy, COVID-19 will damage health not just now but also in the future. Therefore, under the current economic situation, an in-depth understanding of current global economic situation is of great significance to enhance countries’ understanding of the world economy in the era of the COVID-19 epidemic. Moreover, it can help to improve the efficiency of dealing with the impact of the economic turmoil. Grasping the national economy from a macro perspective is of great theoretical value and research significance for economic policy makers and economists.

Bashir et al. (2020) briefly analyzed the impact of COVID-19 on the environment, social and economic changes and also the impact of quarantine policy on air quality. Pattnaik et al. (2020) conducted a bibliometric analysis of Trade Credit before and after the global financial crisis of 2008. This study reported that with the COVID-19 epidemic locking down global operations, the role of trade credit in this situation may attract more academic attention in this field. Early research on COVID-19 by bibliometric analysis focused on the relevant publications in the business and economic fields (Alshater et al., 2022; Nagy et al., 2021), and the VOSviewer software was used to perform the network analysis. Given the economic impact of COVID-19, some scholars reviewed the economy in specific fields. Mody et al. (2021) launched a critical review of the research on the sharing economy. Li and Xu (2021) made a comprehensive overview and analysis of the publications in the field of financial innovation up to 2020. In general, these studies used qualitative or quantitative methods. As far as we know, very few articles have made qualitative and quantitative analysis on the social networks and expanded to multiple possible future directions of concern.

In this paper, bibliometrics analysis and social network analysis methods are used to analyze published literatures on the economic impact of COVID-19 since December 2019. Specifically, to further
understand this field, this paper mainly makes the contributions as follows: (1) This paper discusses published literatures from multiple levels, including countries/regions, institutions and authors, and then performs cluster analysis based on the citation network generated by "economy" research literatures, so as to understand the hot issues of this research. (2) Social network analysis is used to quantify the degree of cooperation, including national cooperation and institutional cooperation (quantitative). (3) By analyzing the contents of important documents, we can understand the issues that the authors pay close attention to and also grasp the future research trends (qualitative).

This paper is separated into multiple sections, which are shown in Figure 2. The remainder of this paper is constructed as follows: In Section 2, the paper introduces the data selection strategy and the study approach. Section 3 analyzes the basic statistical characteristics and research directions, and shows the most productive country and the most influential institution. Then, based on the contents of the literatures, Section 4 analyzes several essential documents. Some discussions about the economic development in the post-epidemic era are exhibited in Section 5. At last, we draw a conclusion for the paper in Section 6.

2. Materials and methodology

2.1. Data selection strategy

On February 8th 2020, the National Health Commission of the People’s Republic of China issued a notice on the temporary name of pneumonia that was caused by COVID-19, which was uniformly named the “novel coronavirus pneumonia”, or “NCP” for short. Dr. Tan Desai, the director general of WHO, held a regular press briefing, at which the official name of this disease caused by the novel coronavirus was announced: Corona Virus Disease 2019, which was abbreviated as COVID-19. On the same day, the virus was also named as 2019 novel corona virus, which was abbreviated to 2019-nCoV by the International Committee on Virology (ICTV). The coronavirus research group of the International Classification Committee of Viruses named it the Severe Respiratory Syndrome Coronavirus 2, or SARS-CoV-2 for short.

Web of Science (WoS) of Clarivate Analytics is the world’s leading information platform for searching and analyzing the scientific quotations. This website was established in 1997, covering more than 8800 SCI journals, 3200 SSCI journals and numerous conference papers (Yu and Pan, 2021; Yu and Sheng, 2020). It is not only used as a research tool to support a wide range of scientific tasks across different knowledge fields, but also used as a data set for large-scale data-intensive research. In the past 20 years, WoS has been applied to thousands of academic research (Li et al., 2018).

To collect more comprehensive documents, we used all the names of COVID-19 and searched them on the Web of Science Core Collection Database. Since COVID-19 began in 2019, the filtered result was 241,074

| Table 1. Query description. |
|-----------------------------|
| Category | Limitation | No. of refined documents |
| Query outcomes before search refine | | 241,074 |
| Title ('Novel coronavirus pneumonia' OR 'Corona Virus Disease, 2019' OR 'COVID-19' OR '2019 novel corona virus' OR '2019-nCoV' OR 'Severe Acute Respiratory Syndrome Coronavirus 2' OR 'SARS-CoV-2') | | |
| Subject area | Limit the search to the following subjects: Economics, Economy, Economic of industrial or economic value and Financial | 2524 |
| Document Types | Excluding resources as meeting abstracts, news and corrections and Books (217) | 2307 |
| Manual Refinement | We reviewed the abstracts and titles of 2307 documents and excluded the irrelevant documents (33) | 2274 |

Source: Author.

Figure 2. The outline of this paper.
documents published till June 2022. Combining with keywords in the economic and financial fields, we further obtained 2307 documents, except 217 meeting minutes, news reports, corrections, and books. Finally, the articles refined in this stage were filtered manually, and 33 articles were excluded by the summary and title of the review documents, resulting in 2274 articles. Table 1 gives a detailed description of the query during the retrieval process.

### 2.2. Study approach

The research team (Albu et al., 2020) analyzed the dynamics of the epidemic spread among people. They reported that this pandemic seriously affected the global economy, and also caused it to decline sharply. After collecting the relevant literatures, the bibliometrics analysis and social network analysis are used to show the current situation and future trends of economic development of various countries in the world in this paper.

Bibliometric analysis is a popular method used to analyze a large number of scientific data, and it is used in various application fields, such as Pythagorean fuzzy sets (Lin et al., 2020), flash translation layer (Luo and Lin, 2021), and wastewater treatment (Chen et al., 2022), while being relatively immature on the emerging areas in a commercial application (Donthu et al., 2021). In recent years, there have been schemes of applying bibliometrics in economy. For example, Zhang et al. (2021) selected a large number of articles published on resource-based theory (RBT), and revealed the status of RBT research. When a crisis strikes, the decision process becomes crucial. Xu et al. (2021) aimed to explore the topic of entrepreneurship and crisis by bibliometric analysis. Budler et al. (2021) discussed contemporary themes and the future research approaches of business models by using the bibliometric methods. Researchers using bibliometric analysis to study research trends in a specific area during the COVID-19 pandemic include Fauzi (2022) who collected relevant literatures from 2019 to 2020 through the web of science database for literature measurement, and analyzed the current and future trends of e-learning in higher education institutions.

What is more, network metrics can be used to enrich the evaluation of bibliometric analysis (Donthu et al., 2021). Social Network Analysis (SNA) is a quantitative analysis of social relations and cooperation, which originated from the adaptive network of physics. It is a method used to analyze the relationship structure and its attributes. “Social network” refers to the collection of social actors and their relationships. Specifically, a social network is a collection composed of multiple social actors and ties between actors. The nodes in the social network represent the participants in this field, and the edges represent the relationships that they have established through co-citation. The participant network in the network is a key influencer identification with the index of betweenness centrality, closeness centrality and harmonic centrality (Wasserman and Faust, 1994). SNA tries to describe the relationship structure between groups and studies its influence on group functions or individuals within groups. In recent years, SNA has been widely used to analyze the authors’ co-authorship, even the co-authorship among countries and institutions. Gephi is a network visualization software for various disciplines (social network analysis, biology, genomics ...). One of its key features is the ability to display the spatialization process, aiming at transforming the network into a map (Jacomy et al., 2014). Not only that, but many scholars also use CiteSpace to explore the research trend in the field. For example, CiteSpace is used as an analysis tool to discover the research trends and patterns in the field of fuzzy theory (Yu et al., 2018).

In this paper, with the help of visualization software: CiteSpace and Gephi, we study the co-authorship of countries and institutions in the economic field under the influence of epidemic situations, to discover the research progress and research mode in this field. We put all the data exported from WoS into the CiteSpace to remove duplicate data, and only keep the articles. The time slicing is selected from 2020 to 2022, and other settings remain the default.

### 3. Results

#### 3.1. Bibliometric overall

In this subsection, we mainly analyze the basic features of the existing literatures from four aspects, i.e., the distribution of types, distribution over publication journals, distribution over research directions, and the influential authors, institutions and countries/regions.

##### 3.1.1. Type and distribution over publication journals

Although COVID-19 appeared in 2019, the first article in the economic field appeared in January 2020. With the seriously damaged global economy has been receiving great attention, articles in this field began to increase greatly. In WoS, all documents are divided into different types. Figure 3 shows the distribution of the document types. 6 types are collected in total amongst these documents, and articles (2023) take up a large proportion, followed by early access (282), editorial materials (176) and review articles (109). By comparison, the share of...
letters (63) and proceeding papers (60) is less than 3%. There are 2713 articles of all types, which is more than 2307 articles we retrieved. This is because some articles belong to more than one type and they may belong to multiple types.

The journal is one of the most important and common ways to publish the research results. There exists a correlation between the journal recognition and publication significance. Figure 4 visualizes the co-citation networks of the ten most productive journals. The bigger circles, the more documents published in the journal. Also, the connection indicates the cooperation between journals. Table 2 lists the total amount of citations, SJR, publisher, etc. of the top ten most productive journals. Among them, SJR was developed by SCImago, which is a new size-independent index of the reputation of scientific journals. This index not only considers the prestige of the cited scientific journals, but also considers the proximity between these cited journals, and uses the cosine of the angle between the co-occurrence curve vectors of two journals (Gueerero-Bote and Moya-Anegón, 2012).

In detail, the set of journals have been ranked according to their SJR and divided into four equal groups, four quartiles. Q1 comprises the quarter of the journals with the highest values, Q2 with the second highest values. We can find that the Sustainability and International Journal of Environmental Research and Public Health are popular, and their total citations are 672 and 565 respectively. PLoS ONE (232), Frontiers in Public Health (211), Environmental Science and Pollution Research (205) and Frontiers in Psychology (192) rank third to sixth, followed by Energies, Finance Research Letters, Resources Policy and Econo-miska Istrazivanja with total citations 127, 82, 73 and 63 respectively. Furthermore, 3 of them, i.e., Sustainability, PLoS ONE, and International Journal of Environmental Research and Public Health have published more than 50 papers on the economy. In terms of SJR, Finance Research Letters is the journal with the highest SJR (2.007), followed by Resources Policy (1.461), Frontiers in Public Health (1.298), Frontiers in Psychology (0.873) and PLoS ONE (0.852).

### 3.1.2. Research directions
Co-citation research is one of the most commonly used methods in the quantitative studies of science, especially Document Co-citation Analysis (DCA) (Chen, 1999). Small (1973) first proposed the concept of
document co-citation. Document co-citation relationship reflects the relevance of research topics or research directions between documents. If two documents are cited at the same time, their research directions are related, and the higher the citation frequency, the stronger the relevance between their research directions. This can be extended to the co-citation relationship of many articles, and then the co-citation network clusters generated by them reflect the common research directions and research themes of articles among clusters. In particular, each cluster label represents a research direction.

The scientific knowledge map can well show the mainstream research direction in this field through information visualization. The time-sharing, pluralistic and dynamic network map can reveal the research hotspots and frontiers in the field of scientific knowledge, which is drawn by the CiteSpace information visualization software system (Chen et al., 2010). The document co-citation network map is shown in Figure 5 (a) and the co-citation clusters are shown in Figure 5 (b).

Table 3 shows the details of document co-citation clusters, which are divided into 11 clusters. The better the clustering effect is, the larger the module value is. In detail, the module value is greater than 0.3, which means that the divided clustering structure is significant; if the average contour value is above 0.5, the clustering is reasonable (Fortunato, 2010). Both graphs show the maximum general graph in the network, with a module value of 0.7373 and an average contour value of 0.919. The marked literature is the basic literature on the economy during the

| Cluster ID | Size | Silhouette | Label (LLR)                                                                 |
|------------|------|------------|-----------------------------------------------------------------------------|
| 0          | 43   | 0.89       | financial market (369.86, 1.0E-4); shaking stability (240.72, 1.0E-4); visegrad group countries (240.72, 1.0E-4); financial resilience (220.88, 1.0E-4); banking market structure (220.88, 1.0E-4) |
| 1          | 39   | 0.938      | economic policy uncertainty (318.03, 1.0E-4); bitcoin return (171.97, 1.0E-4); COVID-19 period (171.97, 1.0E-4); safe haven asset (152.7, 1.0E-4); economic uncertainties (152.7, 1.0E-4) |
| 2          | 39   | 0.925      | coronavirus disease (303.71, 1.0E-4); political architecture (234.85, 1.0E-4); global epidemiology (222.89, 1.0E-4); country healthcare resource (222.89, 1.0E-4); daily cumulative index mortality (222.89, 1.0E-4) |
| 3          | 37   | 0.908      | air quality (472.53, 1.0E-4); COVID-19 lockdown (246.99, 1.0E-4); socio-economic shock (217.23, 1.0E-4); sustainable production (217.23, 1.0E-4); global supply chain (217.23, 1.0E-4) |
| 4          | 36   | 0.912      | economic recovery scenario (225.38, 1.0E-4); economic cost (219.77, 1.0E-4); high-frequency shipping data (205.83, 1.0E-4); COVID-19 lockdown measure (205.83, 1.0E-4); social distancing intervention (186.46, 1.0E-4) |
| 5          | 29   | 0.868      | corporate tax avoidance (149.46, 1.0E-4); event study analysis (111.16, 1.0E-4); stock price (111.16, 1.0E-4); non-financial stock (111.16, 1.0E-4); energy market (94.8, 1.0E-4) |
| 6          | 24   | 0.983      | global financial crisis (180.6, 1.0E-4); pandemic dynamics (141.17, 1.0E-4); financial management (141.17, 1.0E-4); spatial-temporal influence (141.17, 1.0E-4); non-pharmaceutical interventions policies (141.17, 1.0E-4) |
| 7          | 22   | 0.88       | economic policy response (246.98, 1.0E-4); literature review (194.61, 1.0E-4); tourism sector influence (180.26, 1.0E-4); monetary unions stock market (160.59, 1.0E-4); empirical analysis (160.59, 1.0E-4) |
| 8          | 17   | 0.967      | suicide pact (193.27, 1.0E-4); treatment negligence (193.27, 1.0E-4); economic distress disability sickness (193.27, 1.0E-4); perception-based assessment (108.72, 1.0E-4); socio-economic crisis (108.72, 1.0E-4) |
| 9          | 13   | 0.958      | rapid assessment (184.53, 1.0E-4); large online sample (184.53, 1.0E-4); financial strain (184.53, 1.0E-4); epidemiological correlate (184.53, 1.0E-4); COVID-19 concern (184.53, 1.0E-4) |
| 10         | 8    | 0.978      | population health economics (122.71, 1.0E-4); economic uncertainty (104.21, 1.0E-4); wastewater-based epidemiology (82.3, 1.0E-4); COVID-19 surveillance (82.3, 1.0E-4); feasibility economy opportunities (82.3, 1.0E-4) |

Source: Author.
epidemic. Meanwhile, the red tag word is extracted from the literature that references the cluster. Log-likelihood ratio (LLR) is an indicator of authenticity. The larger the LLR, the more representative the label is in this cluster. The top title terms of LLR are selected as cluster labels. Cluster 0 with “financial market” as the core contains 5 items; Cluster 1 with “economic policy uncertainty” contains 5 items; Cluster 2 with “coronavirus disease” contains 5 items; Cluster 3 with “air quality” contains 5 items; Cluster 4 with “economic recovery scenario” contains 5 items; Cluster 5 with “corporate tax avoidance” contains 5 items; Cluster 6 with “global financial crisis” contains 5 items; Cluster 7 with “economic policy response” contains 5 items; Cluster 8 with “suicide pact” contains 5 items; Cluster 9 containing 5 items is centered in “rapid assessment” and Cluster 10 with “population health economics” contains 5 items. We could easily find that the research directions focus on the global financial crisis and policies which are used to change the current economic situation.

3.1.3. Where and who pay more attention to the economy during COVID-19?

According to the statistics of Web of Science, the documents span 167 countries/regions related to this field, involving 3662 institutions and 9354 authors all over the world. The number of articles published by the country is one of the important indicators to reflect the country’s attention degree to this field. Figure 6 shows the number of papers that are issued by all countries. In Figure 6, the darker the blue, the more publications the country/region has. As a result, productivity in the United States is the highest, with 692 papers published. The second place is China, and the third is England.

As indicated in Table 4, there are the top 12 most productive countries/regions based on TC, including the total number of publications (TP), the total number of citations (TC) and the average citations per publications (AC). It can be observed that the USA is the most influential country with 2952 citations, China has 2282 citations, and it ranks second, followed by England which has 1265 citations. The USA, has the highest TP and the highest TC, showing that its research results have made great contributions to this field. From December 31, 2019, the Wuhan Municipal Health and Health Commission issued the first notice on the pneumonia epidemic. In the following months, the epidemic has broken out across China. As the first country to have an epidemic, the number of articles issued in China has gradually increased. With the global outbreak in March, the nationwide seven-day incidence rate of COVID-19 infections in the United States rose fast. The US ranked first in terms of the number of new coronavirus cases; the British economy was most affected by the epidemic. Therefore, we can find that the severity of the national epidemic situation is related to the number of articles published by authors might be explained, which affects the number of articles published to a certain extent.

In Figure 7, the nodes denote an institution, and the size of the node represents the number of papers published by the institutions. The connection between the two nodes indicates the cooperation between the two institutions. The basic information of the literature about the top 10 most relevant institutions are listed in Table 5. It is obvious that the League of European Research Universities (LERU) has the highest number of publications, which has published 126 documents. The University of London ranked number 2 on the list, followed by the University of California (No. 3), Harvard University (No. 4), and Udice French Research Universities (No. 5). Amongst the top ten institutions, the USA has four institutions, and the United Kingdom has two institutions, and

![Figure 6. Density map of publications in different countries/regions.](image-url)
the remaining institutions are located in China, France, Canada and Europe.

In terms of authors, Figure 8 lists some details about the top 10 highly cited authors of documents. Li J from China is the most influential author with 215 citations, followed by Zhang X from China. It is worth mentioning that Nassani AA and Zaman K have accomplished many papers together.

### Table 5. Most relevant institutions.

| Rank | Institution                                      | TP  | TC  | AC  |
|------|--------------------------------------------------|-----|-----|-----|
| 1    | LEAGUE OF EUROPEAN RESEARCH UNIVERSITIES         | 126 | 722 | 5.73|
| 2    | UNIVERSITY OF LONDON                             | 72  | 335 | 4.65|
| 3    | UNIVERSITY OF CALIFORNIA                         | 48  | 257 | 5.35|
| 4    | HARVARD UNIVERSITY                               | 42  | 245 | 5.83|
| 5    | UDICE FRENCH RESEARCH UNIVERSITIES               | 22  | 155 | 7.05|
| 6    | CHINESE ACADEMY OF SCIENCES                      | 21  | 150 | 7.14|
| 7    | STATE UNIVERSITY SYSTEM OF FLORIDA               | 21  | 148 | 7.05|
| 8    | UNIVERSITY COLLEGE LONDON                        | 72  | 136 | 1.89|
| 9    | UNIVERSITY OF TORONTO                            | 17  | 135 | 7.94|
| 10   | JOHNS HOPKINS UNIVERSITY                         | 30  | 128 | 4.27|

Source: Author.

### Table 6. The top 12 countries/regions based on Betweenness.

| Country          | Betweenness | Closeness | Harmonic | Publication |
|------------------|-------------|-----------|----------|-------------|
| FRANCE           | 0.0361      | 0.5354    | 0.6101   | 85          |
| PHILIPPINES      | 0.0335      | 0.5579    | 0.6384   | 13          |
| ARGENTINA        | 0.0326      | 0.5248    | 0.5920   | 35          |
| SCOTLAND         | 0.0322      | 0.5222    | 0.5991   | 12          |
| CROATIA          | 0.0302      | 0.4569    | 0.5157   | 21          |
| GREECE           | 0.0301      | 0.5492    | 0.6274   | 52          |
| KOSOVO           | 0.0295      | 0.5130    | 0.6194   | 1           |
| U ARAB EMIRATES  | 0.0281      | 0.5146    | 0.5943   | 37          |
| SOUTH AFRICA     | 0.0274      | 0.5222    | 0.6030   | 113         |
| INDIA            | 0.0272      | 0.4753    | 0.5472   | 52          |
| ENGLAND          | 0.0267      | 0.5354    | 0.6108   | 241         |
| MALAYSIA         | 0.0261      | 0.5436    | 0.6179   | 60          |

Source: Author.

### 3.2. Social network analysis

#### 3.2.1. The most impactful country/region

It is helpful to understand the degree of cooperation of the countries in the world in the economic field by using social network analysis of the literature from the national level. It is hard to further analyze the future development in the economic field during the period of COVID-19 without analyzing the cooperation network between countries. At the node level of analysis, centrality is the most widely studied attribute, which shows the structural importance or significance of a node in a
network. Centrality mainly includes three types: betweenness centrality, closeness centrality and harmonic centrality. For example, Freeman’s (1979) betweenness centrality metric, which refers to the degree of separation between a node and other nodes in the network, represents the extent to which a node is the intermediary point of other nodes in the network. It is used to highlight the potential key point of paradigm shift over time (Chen, 2006). In short, a node with a high degree of betweenness centrality has the ability to slow down the flow of information or distort the information being conveyed, because it acts as a hub for communication within the network (Borgatti et al., 2009).

Import the data into CiteSpace to generate Figure 9, which is a cooperative network of countries/regions with 171 effective nodes and 513 effective edges. Then by using Excel’s text import wizard, the collected network path data is correctly imported into Excel to preprocess the data. The density of a graph measures the integrity of a network. The higher the ratio, the greater the degree of connectivity of the network. Network density will affect the dissemination and mutual penetration of information in the network. The network with high density has stronger cooperation relationships and better interactivity. The graph density is 0.097 calculated by Gephi software, which indicates that the country’s cooperation network has low connection density and poor connectivity. This shows that the overall level of cooperation and communication between countries is not high. In the face of major disasters, countries should strengthen cooperation and work together to deal with the epidemic. Based on the Gephi software, calculate all the centrality of Figure 11.

Figure 10. The top 20 countries/regions based on betweenness centrality on the map.

Figure 11. The cooperation network of institutions as of June 2021.

Figure 12. The cooperation network of institutions as of June 2022.
nodes, and the network nodes are sorted according to the betweenness centrality. The larger the font, the higher the betweenness centrality of the nodes.

The specific data are shown in Table 6. As can be seen from the nature of network nodes, France has more cooperation with other countries. It shows the relatively high betweenness centrality, closeness centrality and harmonic centrality, which are 0.0361, 0.5354 and 0.6101, respectively. All these figures have fully demonstrated that France is indispensable in the social cooperation network. The high betweenness centrality indicates that France has strong control and influence in the network, cooperating with many countries, sharing knowledge and influencing most of them, followed by Philippines (0.0335) and Argentina (0.0326). The fact that Philippines (0.5579) has the highest closeness centrality indicates that Philippines has high independence in the social network, followed by Greece (0.5492) and Malaysia (0.5436); and the highest harmonic centrality indicates that Philippines (0.6384) occupies a high position in the network. To be precise, the Philippines is a core member of the network, which has established ties with many other important countries, followed by Greece (0.6274) and Kosovo (0.6194).

It should be noted that, although the United States, China and the United Kingdom rank among the top three in terms of publication volume, they rank low in terms of centrality, which shows that they have greatly improved their cooperation depth and knowledge sharing, especially the United States. And they are also deficient in extensive cooperation and sharing of research results. On the whole, there is a certain degree of cooperation around the world.

Figure 10 shows the distribution of the top 20 countries on the map according to the betweenness centrality. What’s interesting is that most...
of these countries are concentrated in the European region, with 11 of the 20 countries being European countries. This situation shows that European regional cooperation has been closely communicated and in-depth cooperation has been established in some regions. After the peak of COVID-19 epidemic, the economy in Europe was hit hard. According to news, on July 19, Europe became the world’s first region with more than 50 million confirmed cases in COVID-19. About one million new cases were confirmed every eight days. So far, more than 6.3 million deaths have been reported. An assessment, which of the impact of the COVID-19 pandemic on household income and the government’s policy response in

**Table 8. The top 10 most essential literature.**

| Rank | Title                                                                 | Cluster ID | Year | Centrality | Author                                                                 |
|------|----------------------------------------------------------------------|------------|------|------------|----------------------------------------------------------------------|
| 1    | Estimating clinical severity of COVID-19 from the transmission dynamics in Wuhan, China | 2          | 2020 | 0.19       | Wu J.T.; Leung K; Bushman M; Kishore N; Niehus R; Salazar; P.M.       |
| 2    | Does economic policy uncertainty predict the Bitcoin returns? An empirical investigation | 1          | 2018 | 0.14       | Demir E; Gozgor G; Lau C.K.M.; Vigne S.A.                             |
| 3    | The Unprecedented Stock Market Reaction to COVID-19                  | 0          | 2020 | 0.13       | Baker S.H.; Bloom N; Davis S.J.; Kost K; Sammon M; Viratyns T        |
| 4    | Global supply-chain effects of COVID-19 control measures             | 4          | 2020 | 0.13       | Guan D; Wang D; Hallegatte S; Davis S.J.; Huo J; Li S                |
| 5    | Effect of restricted emissions during COVID-19 on air quality in India | 3          | 2020 | 0.12       | Sharma S; Zhang M; Anshika; Gao J; Zhang; Kota S                    |
| 6    | Responding to Covid-19 — A Once-in-a-Century Pandemic?              | 2          | 2020 | 0.12       | Gates B                                                              |
| 7    | The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China | 3          | 2020 | 0.11       | Lau H; Khorasangpour V; Kochbach P; Mikołajczyk A; Schubert J; Bania J |
| 8    | The impact of COVID-19 on valuations of non-financial European firms | 6          | 2020 | 0.11       | Rizvi S.K.A.; Yarovaya I; Mirza N; Naqvi B                            |
| 9    | Modelling the Economic Impact and Ripple Effects of Disease Outbreaks | 0          | 2020 | 0.11       | Yu K.D.S.; Aviso K.B.                                                |
| 10   | Pandemics, tourism and global change: a rapid assessment of COVID-19 | 2          | 2021 | 0.10       | Gössling S, Scott D; Hall C. M.                                      |

Source: Author.

**Table 9. The top 10 highly cited publications.**

| Rank | Title                                                                 | TC     | Year | AC   | Author                                                                 |
|------|----------------------------------------------------------------------|--------|------|------|----------------------------------------------------------------------|
| 1    | The socio-economic implications of the coronavirus pandemic (COVID-19): A review | 4787   | 2020 | 1595.7 | Nicola M; Alsaifi Z; Sohrabi C; Kerwan A; ALJahir A; Iosifidis C |
| 2    | Financial markets under the global pandemic of COVID-19               | 1475   | 2020 | 491.7 | Zhang D; Hu M; Ji Q                                                  |
| 3    | COVID-19 and finance: Agendas for future research                    | 969    | 2020 | 323   | Goodell J.W.                                                        |
| 4    | COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: Fresh evidence from the wavelet-based approach | 713    | 2020 | 239   | Sharif A; Aloisi C; Yarovaya L                                      |
| 5    | Economic and social consequences of human mobility restrictions under COVID-19 | 657    | 2020 | 219   | Bonaccorsi G; Pierri F;                                              |
| 6    | Impacts of social and economic factors on the transmission of coronavirus disease 2019 (COVID-19) in China | 469    | 2020 | 156.3 | Qiu Y; Chen X; Shi W                                               |
| 7    | Financial contagion during COVID–19 crisis                          | 439    | 2021 | 219.5 | Akhtaruzzaman M; Boubaker S; Sensoy A                               |
| 8    | The economics of COVID-19: initial empirical evidence on how family firms in five European countries cope with the corona crisis | 428    | 2020 | 142.7 | Kraus S; Claus T; Tiberius V                                       |
| 9    | Computational analysis of SARS-CoV-2/COVID-19 surveillance by wastewater-based epidemiology locally and globally: Feasibility, economy, opportunities and challenges | 366    | 2020 | 122   | Hart O.E.; Halden R.U.                                              |
| 10   | The Response in Air Quality to the Reduction of Chinese Economic Activities During the COVID-19 Outbreak | 297    | 2020 | 99    | Shi X.Q; Brasseur G.P.                                               |

Source: Author.
four hard-hit European countries, found that living standards in all countries had deteriorated as a result of the COVID-19 crisis and a large number of workers affected by the labour market shocks had fallen into poverty (Cantó et al., 2022). Therefore, it is not hard to see that the close cooperation among scholars in the European region is related to the serious economic damage.

3.2.2. What is the distribution of scientific research strength?

In order to better evaluate the input and development of research, we should focus on the scientific research level of the institutions. If the level of scientific research in institution is high, it indicates that the research in this field enjoys strong scientific research support and there will be significant research progress in the future. Table 5 has shown the number of articles published by various institutions. It can be seen that there is no obvious gap in the number of articles published by institutions, but the gap can be reflected in the social cooperation network. Gephi is used to generate the institutional cooperation network, and the layout is set as Force Atlas. Only the top 10 institutions are shown in the figure based on betweenness centrality. In addition, since the dynamic analysis of the evolution of institutional cooperation based on sub-periods is helpful to describe the changes in institution collaboration (Yu et al., 2021), this paper divides the changes of institutional cooperation into two stages. Figure 11 shows the cooperation among agencies as of June 2021, while Figure 12 shows the cooperation among agencies as of June 2022.

As shown in Figure 11, the darker the color of the nodes, the higher the centrality of the nodes; the thicker the lines between the nodes, the closer the cooperation between the two nodes. There is cooperation among most countries. But some nodes are relatively independent and do not cooperate with each other. And in Figure 12, We can see the changes of cooperation among institutions one year later. Compared with last year, the cooperation among institutions has been significantly strengthened. Previously independent (decentralized) institutions have gradually cooperated and formed obvious cooperation blocks (several yellow nodes).

The results of ranking 12 institutions according to their betweenness centrality are shown in Table 7. It is obvious that Harvard University has the highest betweenness centrality. Harvard Medical School, which is the world’s top university for medical and has considerable research in immunology, neuroscience and virology. And Harvard is the world’s top private university. As the oldest institution of higher learning in the United States, Harvard is also one of the most prestigious institutions of higher learning in the world. The second is the University of California, San Francisco (UCSF), which is considered one of the world’s preeminent medical and life sciences universities. UCSF is the only university in the University of California system that only focuses on health and life sciences and only carries out strict graduate education. It is famous for medicine and life sciences. The third is Northeastern University, ranking 39th (top 50) in the comprehensive ranking of American universities in 2017 U.S. news. The engineering, computer science, clinical medicine, biomedicine, architecture, international business and other majors of the university are among the top 50 in the United States. In recent years, has developed into a large-scale higher education institution across the East and west of the United States. Harvard also has the highest closeness centrality, followed by Northeastern University and Chinese Culture University. Harvard is also the world’s top private research university with the reputation of ‘New Ivies’. Similarly, Harvard has the highest harmonic centrality, followed by Northeastern University, Chinese Culture University, etc.

These mean that the global economic situation has been highly valued by high-level institutions, and support for research is strong, but the main force of research is concentrated in a few institutions mainly. On the whole, with the support of a strong scientific research force, the research progress in the economic field will be significant in the future, and the global economy will surely recover from the epidemic soon.

4. Content analysis

Studying a large number of documents in this field and quoting high-quality and valuable documents are used to know the development trend of a field. The number of citations of a document represents its popularity and recognition. For example, if we want to grasp the development trends in the economic field, we can start with researches of highly cited documents. Figure 13 is a timeline view of co-cited clustering by June 2021. It should be noted that the circle not only expresses the information of cited frequency, but also conveys other information. Nodes with purple circles are nodes with centrality greater than 0.1, which means that this document is important in the co-cited network, and this article probably acts as Structural Hole (Zhu et al., 2017). Structural Hole plays an important role in information dissemination, which has a better position in social networks to expand the scope of information dissemination (Gong et al., 2020b). In other words, the article with purple outer circle plays a pivotal role in this field and it connects different clusters. For example, without the article “The Unprecedented Stock Market Reaction to COVID-19” written by Baker et al. (2020), cluster No. 0 “financial market” and the cluster No. 10 “population health economics” would not be related.

In contrast, the key areas of concern have become “large industrial region”, “economic evaluation”, “cross-sectional analysis”, “green economic recovery”, and “spatiotemporal pattern” through June 2022 (see Figure 14). Table 8 lists the top 10 central literature in the document co-citation network. On the basis of the important documents mentioned above, scholars have conducted further research in this field and published high-quality documents. The number of citations is one of the important indexes to measure the quality of documents. Table 9 lists the top 10 highly cited literature in this field. An interesting discovery is that only one document is a single-authored publication in Table 9, and more than half of the documents have more than three authors in Table 8. This phenomenon shows that the level of authors’ collaboration is relatively high and multi-author collaboration is the main pattern.

Compared with previous pandemics, the COVID-19 epidemic has had an unprecedented impact on the US stock market. Policies such as travel restrictions, mall closures, and social distancing restrictions have caused great damage to the economy (Baker et al., 2020). Bitcoin can be used as a hedging tool, which can resist the huge threat caused by extreme economic uncertainty (Demir et al., 2018). Individual countries did not fully consider the impact of this policy on the global supply chain before formulating the epidemic control policy. Epidemic control should be made by the joint efforts of the global community, and support and help should be given to countries with low economic levels (Guan et al., 2020). Moreover, the epidemic has had an impact on the environment. Since the outbreak of COVID-19, pollutants have decreased to varying degrees in most areas, among which PM2.5 has the largest decline, but the concentration of ozone has increased (Sharma et al., 2020). Wu et al. (2020) predicted that after the first wave of global infection, vaccines are likely to be put into use and curb the epidemic effectively.

In Table 9, the most cited articles were published in 2020 written by Nicola et al. (2020), with the highest TC (4787) and the highest AC (1595.7). Specifically speaking, the results of the top 10 highly total cited publications show that COVID-19 has aroused concern about the upcoming economic crisis and recession, and the economic sector is facing a major crisis. According to the results of literature research, the economic impacts of COVID-19 generally can be analyzed from different perspectives. For economists, COVID-19 has brought greater geopolitical risks, and people have different views on the COVID-19 crisis, which is generally regarded as an economic crisis (Sharif et al., 2020). The COVID-19 pandemic is causing direct damage to the global economy, and this influence exists in every region of the world. The problems to be considered in the future will be costs of capital, pension planning, insurance, the role of the government in protecting the financial system, social trust and the impact of concrete transaction costs. In particular, the political stability of society is also a problem that needs to be considered in the future (Goodell, 2020). During
the outbreak, the correlation between financial companies and stock returns increased greatly, which played an important role in financial contagion transmission, and the hedging cost also increased during the outbreak (Akhtaruzzaman and Boubaker, 2021). The COVID-19 crisis brought challenges to the company, but brought stronger unity and cohesion within the company. In the long run, these will make the surviving industries stronger. There is going to be significant but unexpected cultural transformations in the future (Kraus et al., 2020).

Secondly, from the perspective of epidemic situation and government policies and measures, the unconventional policy intervention adopted by the government will cause further uncertainty to the economy and may lead to long-term problems. In addition, countries have not met these challenges jointly, and the trend of global social disintegration is more threatening than viruses (Zhang et al., 2020). The blockade has had an obvious impact on cities with a serious gap between the rich and the poor, and poor people are more vulnerable to the economic consequences brought about by the epidemic blockade (Bonaccorsi et al., 2020). Waste water-based epidemiology (WBE) can be used to track COVID-19, and it can be widely used around the world. It can provide information for local decision-making departments, and especially can help resource-poor areas to balance economic recovery more selectively. Curbing the spread of economic recovery could be balanced locally more selectively with the need for containing community spread of the coronavirus in communities (Hart and Halden, 2020). Implementing social distancing, mandatory quarantine and city lockdown are conducive to curbing the development of the epidemic (Qiu et al., 2020).

Finally, with the blockade imposed by the outbreak of COVID-19 in China, the concentration of ozone in the air has increased (Shi and Brasseur, 2020). As we can see, the topics about the economy during the epidemic concentrated on government policies, economic crisis and financial companies. These 20 papers have important reference value for economic research in epidemic situation.

5. Discussion on economic development in post-epidemic era

Among the existing studies on economy, most of them focus on the economic impact of the epidemic, the effect of policy intervention, and the response of financial markets to the epidemic. In the other part, the change of pollutant concentration is studied. By studying the high-quality articles published recently, we find that more and more researchers have mentioned business recovery, circular economy, sharing economy, safety economics, innovation, and technology prediction in the post-epidemic era.

First of all, it can be predicted that resource allocation is still essential in the post-epidemic era. The epidemic has caused the unsmooth connection of industrial chains. From the micro level, the epidemic has brought important influence on the whole process of enterprise supply chain management, including planning, purchasing, manufacturing, delivery, recycling and so on. What can’t be concealed is the panic of all the players in the market about the future economic uncertainty after the epidemic. In this economic uncertainty, Bitcoin has become the winner of the United States to hedge (Umar et al., 2021). Under the impact of the epidemic, risk aversion has become the theme of implementing the global capital market in 2020 for a whole year, and also lasted until 2021. Each country should be prepared to meet the challenges of the future supply chain, so as to make up for the structural impact of the epidemic on the industry and reduce the risk of supply chain breakage. And we should also carefully manage the risks and flexibility of the supply chain caused by the fragility of supply chain (Nandi et al., 2021). Santeramo (2022) stressed that future research should focus on the relationship between “food waste and environmental impact”, and stressed the need to adopt a multidisciplinary approach to study the complex relationship between food waste and the environment.

Secondly, safety economics is a potential research field in the future. Safety economics requires companies to balance the contradiction between epidemic control and economic development. It is impossible for the country to completely minimize the economic risks brought about by the epidemic (Anderson et al., 2020). To reduce risks and make decisions accurate and effective, safety economics plays an essential role (Nandi et al., 2021). Including sharing economy, circular economy and digital economy after the epidemic, they also need to involve safety economics. In the future, more research needs to be invested in improving the flexibility of enterprises (Caballero-Morales, 2021).

Finally, the psychological problems caused by economic pressure in the post-epidemic era need to be paid attention to. During COVID-19, low-income people seem to be more susceptible to mental illness (Ettman et al., 2021). Financial distress and increased anxiety caused by low socio-economic status are more common in areas with high epidemic risk than in other areas (Chen et al., 2021). However, most areas are not aware of the health problems caused by financial pressure. Paying attention to the mental health problems of low-income people plays an important role in fighting the pandemic. And some studies have shown that perceived threat is significantly negatively correlated with job satisfaction (Cheng and Kao, 2022), which means that in the post-epidemic era, enterprises need to pay more attention to the mental health status of employees to stabilize the turbulent economic state.

6. Conclusions

In this paper, COVID-19 and published literature in the economic field are comprehensively reviewed. This paper analyzed the COVID-19 pandemic from both qualitative and quantitative perspectives, and conducted in-depth social network analysis and content analysis on countries and institutions. In addition, this paper discussed and analyzed the possible research directions in the post epidemic Era.

First of all, it introduces the basic statistical characteristics of literature, including the publication status at the level of country, institution and author. On the whole, more than 3/4 of the collected literature is articles. Sustainability is the most popular journal in this field. Furthermore, from the cluster analysis, it shows that the research direction of COVID-19 and the economy is roughly in the global financial crisis and the policy of adjusting the current economic situation. Among them, three countries, namely the United States, China and Britain, are most concerned about this field.

Besides, through the analysis of social network, the cooperation between counties/regions and institutions in the economic field is deeply studied. It is found that there is more regional cooperation. And there is a lack of knowledge sharing, but on the whole, there is a tendency for global cooperation. In addition, there is strong scientific research support in this field, and achievements of development should be more remarkable in the future.

Through the analysis of literature content, we found that the research topics on the economy during the epidemic period focused on three aspects, namely, economic impact, the effect of policy intervention, and the response of financial markets to the epidemic. As a matter of fact, how to adjust the allocation of resources and relieve the pressure of supply chain rupture caused by the epidemic is still a hot issue. More attention should also be paid to the psychological problems brought about by economic pressure in the post-epidemic era. From now on, we must be fully prepared for the consequences of the global financial crisis.

Declarations

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

Funding statement

This work was supported by Funding body name (U1805263).
Data availability statement

Data included in article/supp. material/referenced in article.

Declaration of interest’s statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgement

This research work was supported by the National Natural Science Foundation of China under Grant No. U1805263.

References

Alchourrオンマン, M., Bouleuter, S., 2021. Financial contagion during COVID-19 crisis. Finance Res. Lett. 38, 101604.
Albu, L., Preda, C.I., Lupo, R., Dobrota, C., Calin, G.M., Boghicevici, C.M., 2020. Estimates of dynamics of the COVID-19 pandemic and of its impact on the economy. Rom. J. Econ. Forecast. 23 (2), 5–17.
Alhajer, M.M., Atayyab, O.F., Khan, A., 2022. What Do we know about business and economics research during COVID-19: a bibliometric review. Econ. Res.-Ekonomska Istraživanja 35 (1), 1884–1912.
Anderson, R.M., Heesterbeek, H., Klinkenberg, D., Hollingsworth, T.D., 2020. How will country-based mitigation measures influence the course of the COVID-19 epidemic? Lancet 395 (10228), 931–934.
Baker, S.R., Bloom, N., Davis, S.J., Kost, K., Sammon, M., Viratyosin, T., Pontiff, J., 2020. The unprecedented stock market reaction to COVID-19. Rev. Asset Pricing Stud. 10 (4), 742–758.
Bareket-Bojmel, L., Shahar, G., Margalit, M., 2020. COVID-19-Related economic anxiety is as high as health anxiety: findings from the USA, the UK, and Israel. Int. J. Cognit. Ther. 14, 566–574.
Bashir, M.F., Ma, B., Shahzad, L., 2020. A brief review of socio-economic and environmental impact of COVID-19. Air Qual., Atmos. Health 13 (12), 1403–1409.
Bonaccorsi, G., Pierri, F., Cinelli, M., Flori, A., 2020. Economic and social consequences of human mobility restrictions under COVID-19. Proc. Natl. Acad. Sci. USA 117 (27), 15530–15535.
Borgatti, S.P., Mehra, A., Brass, D., Labianca, G., 2009. Network analysis in the social sciences. Science 323 (5916), 892–895.
Budler, M., Zupic, I., Trkman, P., 2021. The development of business model research: a bibliometric review. J. Bus. Res. 135, 480.
Ciu, G.M., Boghicevici, C.M., 2020. Estimates of dynamics of the COVID-19 pandemic and of its impact on the economy: the impact of COVID-19 disruptions. J. Pol. Model. 43 (2), 298–316.
Gong, B.L., Zhang, S.R., Yuan, L.R., Chen, K.Z., 2020a. A balance act: minimizing economic loss while controlling novel coronavirus pneumonia. J. Chin. Govern. 5 (2), 249–268.
Gong, C., Du, Y.J., Li, X.Y., Chen, X.L., Li, X.Y., Wang, Y.K., Zhou, Q.Y., 2020b. Structural hole-based approach to control public opinion in a social network. Eng. Appl. Artif. Intell. 93, 106900.
Goodell, J.W., 2020. COVID-19 and finance: agendas for future research. Finance Res. Lett. 35, 101512.
Gou, X., Xiao, P., Huang, D., Deng, F., 2021. Probabilistic double hierachy level alternative queuing model for real economy development evaluation under the perspective of economic financialization. Econ. Res.-Ekonomska Istraživanja 34 (1), 3225–3244.
Guo, M.D., Wang, D.P., Hallegatte, S., Davis, S.J., Hsu, J.W., Li, S.P., Bai, Y.C., Lei, Y.T., Yue, Q.Y., Coffman, D., Cheng, D.Y, Chen, F.P., Liang, X., Xu, B., Lu, X.S., Wang, S.Y., Hubacek, K., Gong, P., 2020. Global supply-chain effects of COVID-19 control measures. Nat. Human Behav. 4 (6), 577–587.
Guerrero-Bote, V.P., Moya-Acènez, F., 2012. A further step forward in measuring journals’ scientific prestige: the SJR indicator. J. Inf. 6 (4), 174–688.
Hart, O.E., Halden, R.U., 2020. Computational analysis of SARS-CoV-2/COVID-19 surveillance by wastewater-based epidemiology locally and globally: feasibility, economy, opportunities and challenges. Sci. Total Environ. 730, 138875.
Jacomy, M.,Venturini, T., Heymann, S., Bastian, M., 2014. ForceAtlas2, a continuous graph layout algorithm for handry network visualization designed for the Gephi software. PLoS One 9 (6), e98679.
Kraus, S., Claus, T., Breier, M., Gan, J., Zardini, A., Tiberius, V., 2020. The economics of COVID-19: initial empirical evidence on how families in five European countries cope with the coronavirus. Int. J. Entrepreneurial Behav. Res. 26 (5), 1007–1092.
Lenzen, M., Li, M.Y., Malik, A., Popponi, F., Sun, Y.Y., Wiedmann, T., Fatuor, F., Fry, J., Gallego, B., Gesche, A., Gomez-Paredes, J., Kanemoto, K., Kenway, S., Nansal, K., Prokopenko, M., Wakiyama, T., Wang, Y.F., Yousefzadeh, M., 2020. Global socio-economic losses and environmental gains from the Coronavirus pandemic. PLoS One 15 (7), e0235654.
Li, B., Xu, Z., 2021. A comprehensive bibliometric analysis of financial innovation. Econ. Res.-Ekonomska Istraživanja 35 (1), 367–390.
Li, K., Rollins, J., Yan, E., 2018. Web of Science used in published research and review papers 1997–2017: a selective, dynamic, cross-domain, content-based analysis. Scientometrics 115 (1), 1–20.
Lin, M.W., Chen, Y.Q., Chen, R., 2020. Bibliometric analysis on Pythagorean fuzzy sets 2017–2020: a selective, dynamic, cross-domain, content-based analysis. Scientometrics 115 (1), 1–20.
Lin, M.W., Chen, Y.Q., Chen, R., 2020. Bibliometric analysis on Pythagorean fuzzy sets during 2013–2020. Int. J. Intelit. Comput. Cyber. 14 (2), 104–112.
Liu, Y.H., Lin, M.W., 2021. Flash translation layer: a review and bibliometric analysis. Int. J. Intelit. Comput. Cyber. 14 (3), 480–508.
McKee, M., Stuckler, D., 2020. If the world fails to protect the economy, COVID-19 will damage health not just now but also in the future. Nat. Med. 26 (5), 640–642.
Mody, M.A., Hanks, L., Cheng, M., 2021. Sharing economy research in hospitality and tourism: a critical review using bibliometric analysis, content analysis and a quantitative systematic literature review. Int. J. Contemp. Hospit. Manag. 33 (5), 1711–1745.
Mou, J.J., 2020. Research on the impact of COVID19 on global economy. IOP Conf. Ser. Earth Environ. Sci. 546, 032043.
Nagy, A.M., Konka, B., Torok, A., 2021. The COVID problem reflected by economics-A bibliometric analysis. Acta Oecon. 71 (51), 205–221.
Nandi, S., Sarkis, J., Hervani, A.A., Helms, M.M., 2021. Redesigning supply chains using blockchain-enabled circular economy and COVID-19 experiences. Sustain. Prod. Consum. 27, 10–22.
Nicola, M., Alfatil, Z., Solhrabi, K., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agma, M., Agha, R., 2020. The socio-economic implications of the coronavirus pandemic (COVID-19): a review. Int. J. Surg. 78, 185–193.
Pattnaik, D., Hasan, M.K., Kumar, S., Paul, J., 2020. Trade credit research before and after the global financial crisis of 2008-A bibliometric overview. Res. Int. Bus. Finance 54, 101287.
Qiu, Y., Chen, X., Shi, W., 2020. Impacts of social and economic factors on the transmission of coronavirus disease 2019 (COVID-19) in China. Popul. Econ. 33 (4), 1127–1172.
Rizvi, S.K.A., Yarovable, I., Mirza, N., Naqvi, B., 2022. The impact of COVID-19 on the Valuations of non-financial European firms. Heliyon 8 (6), e09486.
Santeramo, F.G., 2022. Circular and green economy: the state-of-the-art. Heliyon 8 (4), e09297.
Sharif, A., Aloui, C., Yarovaya, L., 2020. COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: fresh evidence from the wavelet-based approach. Int. Rev. Financ. Anal. 70, 101496.
Sharma, S., Zhang, M.Y., Anshika, Gao, J.S., Zhang, H.L., Kosa, S.H., 2020. Effect of restricted emissions during COVID-19 on air quality in India. Sci. Total Environ. 728, 138878.
Shi, X.Q., Brasseur, G.P., 2020. The response in air quality to the reduction of Chinese economic activities during the COVID-19 outbreak. Geophys. Res. Lett. 47 (11), e2020GL088070.
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.
Umar, M., Su, C.W., Rizvi, S.K.A., Shao, X.F., 2021. Bitcoin: a safe haven asset and a winner amid political and economic uncertainties in the US? Technol. Forecast. Soc. Change 167, 120680.
Wasserman, S., Faust, K., 1994. Social Network Analysis: Methods and Applications. Cambridge University Press, Cambridge, pp. 190–193.
Wei, X., Li, L., Zhang, F., 2021. The impact of the COVID-19 pandemic on socio-economic and sustainability. Environ. Sci. Pollut. Control Ser. 28 (48), 68251–68260.
Wu, J.T., Leung, K., Bushman, M., Kishore, N., Nichux, R., de Salazar, P.M., Cowling, B.J., Lipsitch, M., Leung, G.M., 2020. Estimating clinical severity of COVID-19 from the transmission dynamics in Wuhan, China. Nat. Med. 26 (4), 506–510.
Xu, Z.S., Wang, X.D., Wang, X.X., Skare, M., 2021. A comprehensive bibliometric analysis of entrepreneurship and crisis literature published from 1984 to 2020. J. Bus. Res. 135, 304–318.
Yarovaya, L., Brzeszczyński, J., Goodell, J.W., Lucey, B., Lau, C.K.M., 2022. Rethinking financial contagion: information transmission mechanism during the COVID-19 pandemic. J. Int. Financ. Market. Inst. Money.
Yu, D.J., Pan, T.X., 2021. Tracing knowledge diffusion of TOPSIS: a historical perspective from citation network. Expert Syst. Appl. 168, 114238.
Yu, D.J., Sheng, L.B., 2020. Knowledge diffusion paths of blockchain domain: the main path analysis. Scientometrics 125 (1), 471–497.
Yu, D.J., Xu, Z.S., Wang, W.R., 2018. Bibliometric analysis of fuzzy theory research in China: a 30-year perspective. Knowl. Base Syst. 141, 188–199.
Yu, D.J., Kou, G., Xu, Z.S., Shi, S.S., 2021. Analysis of collaboration evolution in AHP research: 1982–2018. Int. J. Inf. Technol. Decis. Making 20 (1), 7–36.
Zhang, J., Lin, M., 2022. A comprehensive bibliometric analysis of Apache Hadoop from 2008 to 2020. Int. J. Intell. Comput. Cybern.
Zhang, D.Y., Hu, M., Ji, Q., 2020. Financial markets under the global pandemic of COVID-19. Finance Res. Lett. 36, 101528.
Zhang, Y.C., Hou, Z.W., Yang, F.F., Yang, M.M., Wang, Z.L., 2021. Discovering the evolution of resource-based theory: science mapping based on bibliometric analysis. J. Bus. Res. 137, 500–516.
Zhu, J.H., Yin, X.M., Wang, Y.K., Li, J.R., Zhong, Y.L., Li, Y.S., 2017. Structural holes theory-based influence maximization in social network. Wireless Algorithms., Syst., Appl., Wasa 2017. 10251, 860–864.