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The Relation between Climate Change and Carbon Emission Trading: A Bibliometric Analysis

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ABSTRACT

The goal of this study is to illustrate the value that climate change adds to carbon emission trading (CET) by examining the papers that were found by doing a literature review on Scopus databases. In this study, the journal addressing the topic of "CET" with the maximum number of records from the sources included in the "Web of Scopus" content has been chosen. The terms "climate change" and "CET" should be searched for simultaneously in every paper published in the journal between the years of 2001 and 2022, according to research utilizing bibliometric analysis. To get at the results and an explanation of the data, a bibliometric analysis and citation mapping process are conducted taking into account all factors. VOSviewer is used to show co-authorship analysis of keywords, co-authorship analysis of citation networks, and bibliometric networks of results and findings in the form of scientific mapping. A technique for assessing a single journal's performance is bibliometric analysis. The validity of a single journal can be evaluated using bibliometric analysis, however there are some restrictions to be aware of. This situation is described in detail as a study constraint. A technique for assessing a single journal's performance is bibliometric analysis. The validity of a single journal can be evaluated using bibliometric analysis, however there are some restrictions to be aware of. One drawback of bibliometric analysis is that it relies on quantitative measurements, like citation counts, which ignore the caliber of the research. It is possible to assess a single journal's performance using bibliometric analysis, but it's necessary to be aware of its limits. The findings of a bibliometric analysis were used in this study to identify contributions, gaps, and limitations. The issue is organized around four clusters: IC, climate change, CET, emission trading and carbon dioxide. It is appropriate to emphasize the paper's originality because previously unknown themes are handled in a creative way.

Keywords: Climate Change, Carbon Emission Trading, Bibliometric Analysis, Web of Scopus, VOSviewer
JEL Classifications: D21, G2, G4, H32, L2

1. INTRODUCTION

Due to a significant amount of greenhouse gas (GHG) emissions brought on either directly or indirectly by human activity over the past century, global warming has been progressively worse. According to the US Environmental Protection Agency, if no measures are taken, the average global temperature will increase to 11.5° by the end of the twenty-first century (Wang et al., 2014). In limiting climate change, carbon emissions are crucial (Zeng et al., 2021). Temperature goals equate to goals for reducing emissions since the amount of carbon dioxide (CO_2) released into the atmosphere as a whole is roughly equal to global warming (Rogelj et al., 2019). Countries have made an effort to stop the rise in global emissions since the 1990s (Millot and Mazi, 2021).

Today's global society is still bound by the chains of anthropogenic climate change (Palmer and Stevens, 2019). The Kyoto Protocol, which highlights the target criteria for GHGs emissions in technologically sophisticated countries (Wegener, 2020), makes these initiatives to reduce or perhaps offset the influence of people

on global warming clear, despite the fact that there have been several attempts to do so. Development may be hampered by the escalating climate change. Since the 1950s, according to a report by the Intergovernmental Panel on Climate Change (IPCC), our planet has seen extreme weather, including heavy rains, heat currents, surges, and droughts (Hou and Wang 2021; Tollefson 2018). Globally, the frequency and volume of rainfall will grow dramatically, and some regions may also experience drought (Byers et al. 2017; Peel 2015; Savaresi 2016).

By reducing global carbon emissions, governments from all over the world are devoted to keeping the earth's temperature below 2°C and, to the greatest extent possible, below 1.5°C. Each signatory nation, including Indonesia, created a Nationally Determined Contribution document following the passage of the Paris Agreement in 2015, which contains action plans to combat climate change. The Indonesian government sets a goal in this paper to reduce GHG emissions by 29% on its own, and up to 41% with international assistance, by 2030. Indonesia is also working to achieve net zero emissions, which is the goal of eliminating all GHG emissions. By 2060 or before, it will be absorbed so that it does not enter the atmosphere.

As a result, this will have an impact on the production and economic growth of many nations (Lelieveld et al. 2019; Muttitt and Kartha 2020). There should be effective coordination of various policies, conservation and low-carbon structures, and technical innovation for different countries to achieve a "win-win" situation and, consequently, maximize potential economic advantages and development while regulating emissions (Zhang et al. 2021; Braulio-Gonzalo, M., Bovea, M.D. (2020).

Due to industrialization-related excessive fossil fuel energy consumption, China is now recognized as a significant GHG emitter and a major location for global emission reduction (Liu and Wu 2017; Yu et al. 2019; Duan, Y., Ji, T., Lu, Y., Wang, S. (2021). In terms of locations generating greater CO2, the United States and some European nations come in second and third, respectively (Cohen et al. 2019; Syed and Ullah 2021; Bretas, V.P.G., Alon, I. (2021) (see Fig. 1). Many of these nations have consented to contribute to climate change mitigation by reducing CO2 emissions as part of their efforts to address challenges related to climate change (De la Hoz-Correa, A., Muñoz-Leiva, F., Bakucz, M. (2018).

However, only a small amount of research uses the bibliometric technique to visualize and map the numerous carbon emission trading (CET) knowledge domains, which concentrate on how CET is implemented in different jurisdictions and how it contributes to low carbon emissions. Despite doing a bibliometric analysis on low carbon growth, Zheng et al.'s work from 2022 was titled "A bibliometric review on carbon accounting in social science during 1997-2020." The researchers investigated how CET is crucial to determining the proper distribution of responsibility for reduction, helping to address the climate catastrophe.

Theoretical problematization of the relationship between climate change and CET is a growing area of research that aims to understand how businesses manage and profit from CET in the context of climate change.

Overall, research on the relationship between climate change and CET is crucial because it will help businesses better understand how to use climate change in the age of global warming (Dantu, R., Dissanayake, I., Nerur, S. (2021). The contribution of climate change to carbon emission trading is rather large in light of all this awareness, taking into account all the factors that have an impact on the development of carbon emission trading and organizational value. In order to answer all of these concerns using bibliometric analysis, the study's current objective is to review all of the publications on carbon emission trading and climate change published in reputable, highly indexed journals (five-year Impact Factor 4.065 according to Scopus CiteScore 202) and other sources (Campiglio, E. (2016); Choi, Y., Zhang, N., Zhou, P. (2012).

The main goal of this study is to visualize network analysis and citation mapping of correlation of type of analysis (co-authorship, co-occurrence, citation, bibliometric coupling, and co-citation) and unit of analysis (author, organization, countries, documents, sources, cited references, cited sources, and cited authors). This is based on the explanatory power of networks. With VOSviewer, several versions of each of these relationships were explored, and the findings and comments section provides a detailed explanation of the findings (Cao, K., Xu, X., Wu, Q., Zhang, Q. (2017; Chen et al., 2015).

The database Scopus, which routinely scans highly indexed journals, conferences, book chapters, etc., to provide access to pertinent and prestigious articles relating to research topics, is chosen for this article's preparation. A thorough bibliometric analysis is planned to investigate and evaluate a sizable amount of scientific data obtained from keywords associated with carbon emission trading and climate change in the aforementioned themes in the scopus database (Casprini, E., Dabic, M., Kotlar, J., Pucci, T. (2020); Chen, H., Xu, Y. (2021).

This study, which is intended to motivate readers to take action, uses bibliometric analysis to address the following research questions:

- RQ1. What are the primary research subfields in CET?
- RQ2. Who are the most significant authors?
- RQ3. What subjects have been researched?

Consequently, the following is the paper's structure: The literature review on CET and its components is presented in the first section. Additionally, the first chapter focuses on the connection between climate change and CET. The research procedure is covered in the second chapter. The second section discusses the research cluster, methodology, analysis, and findings. The conclusion and discussion summarize the key findings and the outlook for the literature on CET and relationships.

2. LITERATURE REVIEW

Duan et al. (2014) examined China's carbon emissions trading pilot; Hepburn (2007) reviewed the arrangements for the Kyoto

mechanism's carbon-emissions trading system; Narassimhan et al. (2018) conducted a thorough study of the implementation of carbon-trading programs in eight locations, whereas Yu and Xu (2017) used CiteSpace to conduct a co-citation visual analysis of a carbon-trading scheme. According to Chen et al. (2021), there was a lag effect in the pilot policy of CETP's reduction of the percentage of green patents, which was roughly 9.26%. According to Zhang and Fu (2022), the cost of carbon trading raises the cost of developing new green technologies. Zeng et al. (2019) found that green innovation is an efficient way to accomplish emission reduction in their studies of the influence of CETP on carbon emissions. According to Li et al. (2020), CETP encourages the development of alliances for the reduction of carbon emissions, and inter-firm collaboration within these alliances can encourage the strengthening of industrial structure. According to Lu et al. (2020), low-carbon alliances help upgrade the industrial structure and function as a dynamic cycle mechanism.

Environmental accounting is a subset of accounting that, according to Schaltegger and Burritt (2000), deals with "activities, methods and systems (as well as) recording, analysis and reporting of environmentally induced financial impacts and ecological impacts of a defined economic system (e.g. firm, plant, region, nation, etc.)" (p.63). The non-monetary and monetary dimensions of environmental accounting are also stressed by Burritt et al. (2002). The United States Environmental Protection Agency (USEPA) (1995), Bennett and James (1998), and Schaltegger and Burritt (2000) all point out that the phrase "environmental accounting" is employed at various scales (Viola, L., Verheul, J. (2020); Xu, M., Lin, B., Wang, S. (2021). Huang and Wang (2013) create ridge regression multiple linear models and discover that each 1% increase in population results in a 0.093% reduction in carbon emissions, while increases in the share of the tertiary sector result in increases in GDP per capita, energy intensity, and urbanization of 0.963%, 0.059%, and 0.266%, respectively. According to Li et al. (2022), uncertainty in trade and monetary policy both positively affect the price of carbon, however exchange rate policy uncertainty has a negative impact on the market price of carbon emission trading (Santos, A., Forte, R. (2021; Tang, K.Y., Chang, C.Y., Hwang, G.J. (2021).

Scholars have looked into the variables influencing carbon emissions after becoming aware of the significant effects carbon emissions have on the economy and environment. According to Chen et al. (2010), who extended their research from the micro to the macro scale, household carbon emissions are significantly correlated with the consumption of electricity, fuel, and materials, as well as with urban population and economic growth. According to Li et al. (2022), uncertainty in trade and monetary policy both positively affect the price of carbon, however exchange rate policy uncertainty has a negative impact on the market price of CET. Ma (2022) finds that CETP greatly worsens the export product quality of businesses in high-energy-consuming industries and severely reduces the export product quality of non-state businesses. According to Daldoul (2018), the transportation industry makes a sizable contribution to carbon emissions, but as energy efficiency rises in the industry, carbon emissions fall. Research and development (R&D) intensity and energy efficiency are factors that hinder carbon emission scale and intensity, according to Wang et al. (2019) analysis. According to Zhang et al. (2021), the value-added of the logistics sector is responsible for 65.45% of carbon emissions. The most populous nations in the world and the major consumers of coal are China and India.

According to Song et al. (2014), the cumulative effects of the energy mix are favorable, whereas the cumulative effects of the industrial structure are unfavorable. According to Fan et al. (2015), the petrochemical industry is a significant producer of carbon emissions and uses a lot of energy (Zhao, X., Liu, C., Sun, C., Yang, M. (2020). While the industrial structure effect reduces carbon emissions, the economic growth effect is the primary factor affecting carbon emissions from the petrochemical industry. Regional changes in industrial structure, according to Tian et al. (2014), have a significant impact on regional carbon emissions. According to Zheng et al. (2019), modernizing the industrial structure reduced carbon emissions across most regions. Additionally, Zhang et al. (2020a) demonstrate that improving the industrial structure indirectly raises carbon intensity by encouraging technical advancement (Piñeiro-Chousa, J., López-Cabarcos, M.Á., Romero-Castro, N.M., Pérez- Pico, A.M. (2020).

The long- and short-term memory (LSTM) method is used by Ahmed et al. (2022) to discover that in both countries, energy consumption has the greatest impact on carbon emissions, while renewable energy sources have the least. Scale efficiency is the primary barrier to improving carbon efficiency in the Yangtze River Economic Zone, according to Liu and Hao (2022). According to Yang et al. (2022b), there are numerous inferred carbon emissions in the export trade, with the change in export scale acting as the primary influence. In their evaluation of emission trading schemes (ETS) and renewable energy policies, Dai et al. (2018) establish that emission trading is a practical way to achieve reduction targets at a lower cost. According to Zhang et al. (2019), the effects of the ETS are minimal in Tianjin, Shanghai, Chongqing, and Hubei, with a considerable reduction in carbon emission intensity only in Beijing and Guangdong. In their analysis of how ETS regulations encourage carbon emission reduction by enhancing technological innovation, Wang et al. (2014) conducted a quasi-natural experiment to demonstrate that emission reduction policies have dynamic cumulative impacts.

According to Wang and Yang (2016), increasing GDP per capita, population growth, changes in intermediate demand, and sectoral emission intensity all contribute to an increase in urban and rural indirect emissions, while lowering energy intensity, residential consumption rates, urban and rural consumption rates, and consumption structure effects can help reduce carbon emissions Niknejad, N., Nazari, B., Foroutani, S., Hussin, A.R.B.C. (2022),. According to Bosello and Roson (2002), the difference between two social utility functions—one that is implicitly maximized in a competitive market equilibrium and the other that is implicitly adopted when choosing a certain equity principle—is what causes the distributional impact of emission trading. Tang and Song (2013) discover that carbon credits can be balanced via government quotas, market exchanges, and purification processes. This allows them to determine the best production plan depending on carbon

emissions (Omoregbe, O., Mustapha, A.N., Steinberger-Wilckens, R., El-Kharouf, A., Onyeaka, H. (2020). With a Shanghai pilot, Wu et al. (2014) advocated that allowance allocation rules should be changed in the pilot region to encourage changes in the domestic energy mix and enhance emissions data disclosure to achieve information symmetry. According to Liu et al. (2012), carbon trading as a market mechanism is a crucial tool for reducing climate change, incorrect allowance distribution, ineffective trading systems, and sluggish legislation Millimet, D.L., Roy, J. (2016).

According to the literature analysis, there is currently a study gap regarding CET. The majority of recent studies have tested the effect of CETP on carbon emissions using quasi-natural experiments, however the results are highly disparate and there is still no agreement on them. Carbon trading has to take substantial steps in this direction to encourage socioeconomic growth that has positive economic effects and a direct influence on carbon emissions.

3. METHODOLOGY

Bibliometric analysis is a technique for analyzing and comprehending scientific publications that makes use of quantitative measurements (Meng, X.C., Seong, Y.H., Lee, M. K. (2021). The methodology is based on the idea that patterns and trends in the literature can provide important details about the state of a certain field, such as its development, research trends, and significant actors (Donthu et al., 2021). By mapping keywords, nations, and authors with bibliographic coupling and co-citation analysis utilizing software for the depiction of similarities, the bibliographic information is shown graphically (Liu et al., 2012; Jiang, K., Ashworth, P. (2021), Kern, F., Rogge, K.S., Howlett, M. (2019),).

In order to do a bibliometric study, publications such as books, articles, and patents must first be gathered. The data must then be analyzed and understood using a variety of quantitative indicators (McBurney and Novak, 2002). Some of the most used measures in this context are:

Citation counts: This metric gauges how frequently a piece of writing is cited in other works. It is used to discover the most well-known individuals and institutions as well as the most often referenced works in a field (Moed et al., 2012; Lin, B., Xu, M. (2019).

Co-citation analysis: This metric examines how easily the citation patterns of several articles may be compared. It is used to identify groups of papers with closely related study topics and themes (Liu et al., 2012; Lyu, X.H., Shi, A., Wang, X. (2020).

Co-authorship analysis: This measure counts the number of papers that numerous authors have co-authored. It is used to identify the writers and organizations that work together most frequently on a particular topic (Ponomariov and Boardman, 2016; Mallapaty, S. (2020).

Network analysis: In this analysis, the relationships between different publications, authors, and institutions are evaluated. It is employed to pinpoint the key players and investigate problems in a field (Van Duijn and Vermunt, 2006).

The goal of bibliometric analysis is to provide a quantitative and objective view of the condition of a field, and it can be used to spot significant trends, research questions, and potential directions for further study. Bibliometric analysis can be utilized to analyze and comprehend a wide range of scientific publications in addition to journal performance analysis (Donthu et al., 2021).

To find important research subjects, trends, and patterns in a certain field, bibliometric analysis is employed. This can provide information on the most popular fields of study and research questions. To identify the most productive authors, institutions, and journals in a particular field, bibliometric analysis is utilized. This can shed light on the influential figures in a field and the top research institutions in that area (Anand et al., 2021).

3.1. Data Collection

Due to the collection of bibliographic information and reliance on solid, trustworthy data (i.e., indexed articles), bibliometric analysis is typically regarded as a quantitative research technique. Particularly, bibliometric analysis may promote a particular area of research on CET and/or climate change. This study's bibliometric analysis is based on the WOS citation database (www.webofknowledge.com). For bibliometrics information retrieval, using the best search engine is crucial (Allam et al., 2022). In addition, SCOPUS gives researchers access to a variety of bibliometric information on the author or piece of work they are looking for. Numerous publishing patterns are used in bibliometric analysis to provide quantitative analysis. According to McBurney and Novak (2002), the topic of bibliometrics comprises a variety of analytical and descriptive methods.

3.2. Data Analysis

Gathering a data set of publications, such as books, articles, or patents, and then analyzing and interpreting the data using various quantitative metrics are common steps in bibliometric analysis (McBurney and Novak, 2002). The bibliometric analysis in this study is carried out in the following sequence:

1. Initially, the www.scopus.com web address was built with the planned query strings "CET" and "climate change" to find the important words in the title, abstract, or keywords.
2. From the articles released between 2001 and 2022, it was determined that the Scopus publication covered the subjects of "climate change" and "CET." The 171 records that were collected from Scopus were then exported to a "plain text file" containing "full record and cited references".
3. The exported data was finally analyzed and narrowed down using text mining software called VOSviewer, created by Van Eck and Waltman (2010), in order to respond to the study question, reveal the findings, and visually inspect the interpretations and findings.
4. Between 2001 and 2022, 171 publications were found through extensive study. Since CET is generally seen as a more recent notion and there was a climate change expression at the time, 2001 was chosen as the promotion year.

4. RESULTS AND DISCUSSION

The most influential writers and the most frequently referenced references can all be reached through bibliometric analysis (Liu et al., 2022). In this sense, bibliometric elements, such as the co-occurrence of keywords in articles and the co-citation analysis utilizing pairs of papers that are frequently cited together, indicate the structural and dynamic characteristics of scientific research. As a result, it is proposed to introduce both analyses in this section with their shared components (Muoz-Villamizar et al., 2019).

4.1. Publication by Year

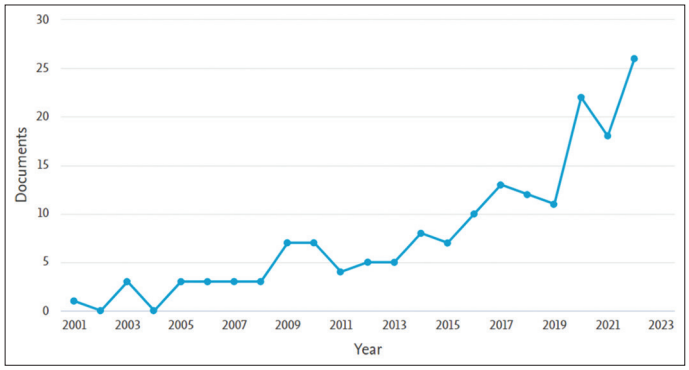
Academics studying accounting have become more interested in CET since 2001. The trend of publications on CET in the business and accounting disciplines has significantly risen over the last 5 years (2001–2022), as can be shown in Figure 1. The study's number trend shows the expansion of scholarly interest in this field and acts as a launchpad for our attempt.

4.2. Citation by Year and Most Cited Documents

The number of citations might give one an idea of a document's importance in a particular area of study (Baier-Fuentes et al., 2019). Figure 2 shows the total amount of publication per year by source. Figure 3 show that publication from most productive journal are technological forecasting and social change, international journal of environmental research and publich health, energy policy, climate policy and journal of cleader production.

This graph also shows the year in which publications are generally more commonly cited along with the most cited paper each year.

Figure 1: Publication by year



4.3. Analysis Publication by Authors and their Productivity

The value of network analysis is supported by the fact that the number of articles with a single author is much higher than the number of publications with multiple authors for each article. Parker (2020), who published 5 articles, was the most productive author. Ye (2020), who published 4 papers, was the second most productive author. The next five productive writers are Jiang, J., Li, Y., Ndiaye, M., Zeng, M., and Zhou, K., who each has published three works in CET and climate change. There are 160 authors in total across the items being looked at, as seen in Figure 2.

4.4. Type of Publication and Subject Area

Taking into account the publishing activity, we discover that there are 10 different types of publications, 171 articles, and 7 publications organized by subject area. These findings provide credence to the need for a study of the organizing ideas of the body of knowledge. Editorian (0,6%), book (0,6%), note (1,2%), review (7,0%), book chapter (9,4%), conference paper (13,5%), and articles (67,8%) are the different types of publications.

The documents under review range in subject and format, but scientific journal articles by a substantial margin predominate (Figures 4 and 5).

As can be seen, the most common subject areas for published articles are multidisciplinary (2.0%), computer sciences (2%), earth and planet (2%), economics and econometrics (7,5%), engineering (9,5%), business and management (9,5%), social sciences (10,4%), energy (16,8), and environmental sciences (26.0%). Figure 5 illustrates the importance of the environmental sciences field when it comes to the topic of CET (26%). The contextualization of CET and climate change domains is a

Figure 2: Publication by authors

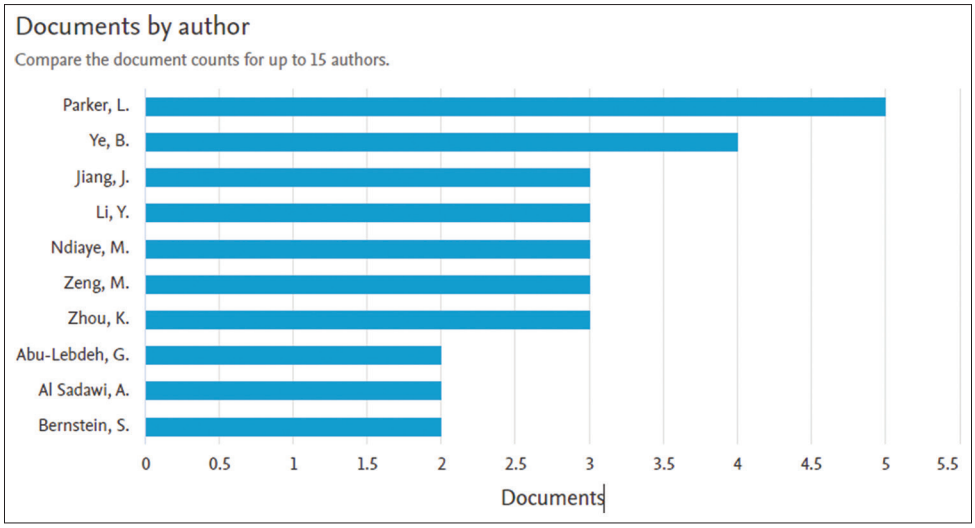


Figure 3: Research per year by source

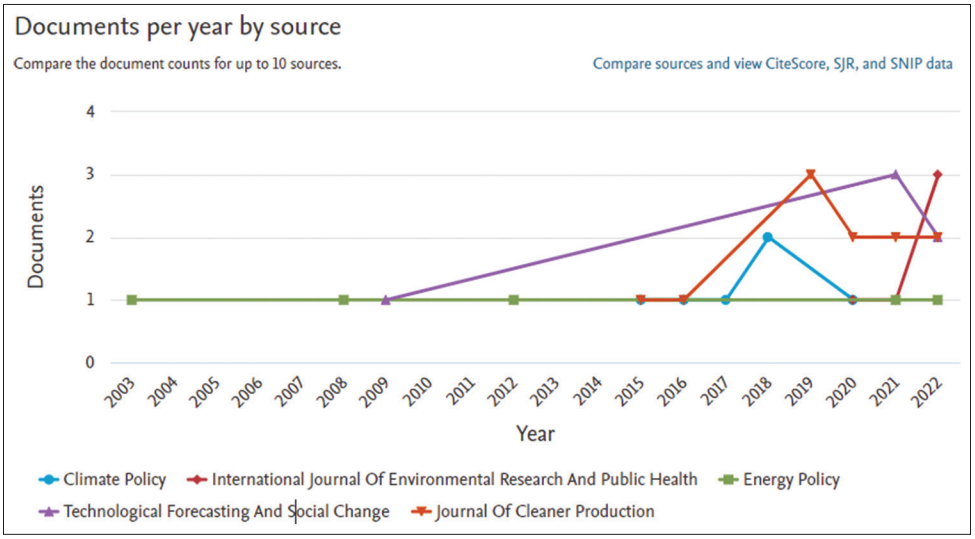


Figure 4: Publication by type

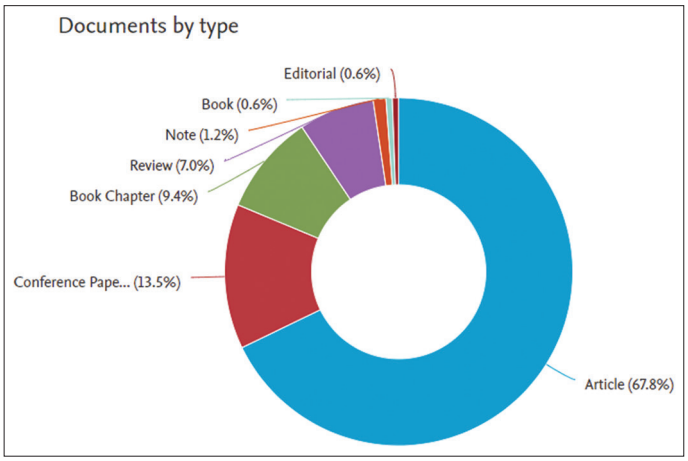
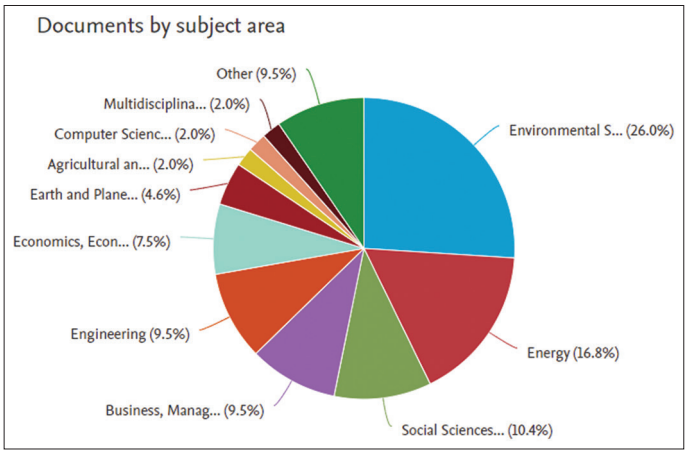


Figure 5: Publication by subject area

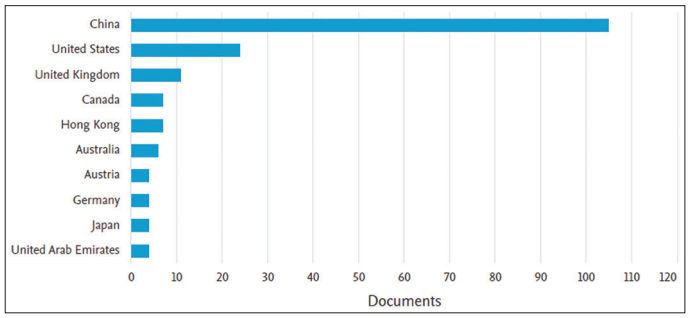


specialized issue that does not generate many journals, despite drawing numerous experts.

4.5. Publishing Activity by Country

It seems like everyone is talking about the usage of CET and climate change these days. The affiliation of the first author in our data set was taken into consideration as the study on this topic was conducted in 36 countries. Each of these countries produces a different number of publications. The top ten countries with at least 100 publications are shown in Figure 6. China is by far the most productive country in the world.

Figure 6: Publication Activity by Country



The top 10 countries were mostly developed and emerging nations, it should be highlighted. Among them are China, the United States, the United Kingdom, Canada, Hong Kong, Australia, Austria, Germany, Japan, and the United Arab Emirates. According to this report, China has one of the highest rates of the most fruitful research publications on CET. Other notable clusters that were detected include the United Kingdom, Canada, and Hong Kong, in addition to the dominant cluster of China and other key clusters like the United States and UK.

4.6. Analysis Publication Activity by Affiliation

The most prolific affiliate, as shown in Figure 7, has contributed to the most developments in the disciplines of CET and climate change. With 12 works, Tsinghua University, a renowned authority in the field of CET analysis, holds the record for most publications. Nort China Electric Power University, Beijing Institute of Technology, Chinese Academy of Sciences, and Wuhan University each had 6 articles published, with each publishing 11 papers.

Figure 7: The most productive affiliation publication on carbon emission trading

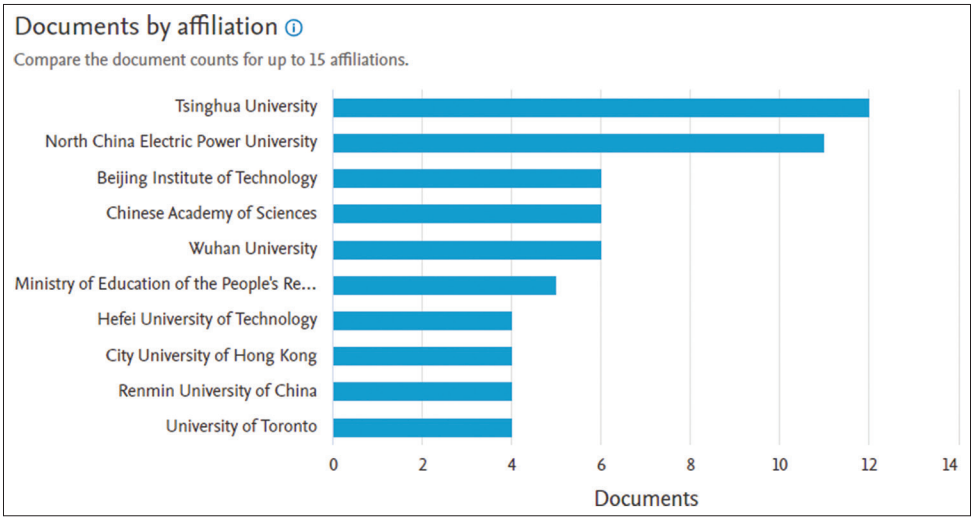


Figure 8: Funding Sponsor writing on artificial intelligence in accounting

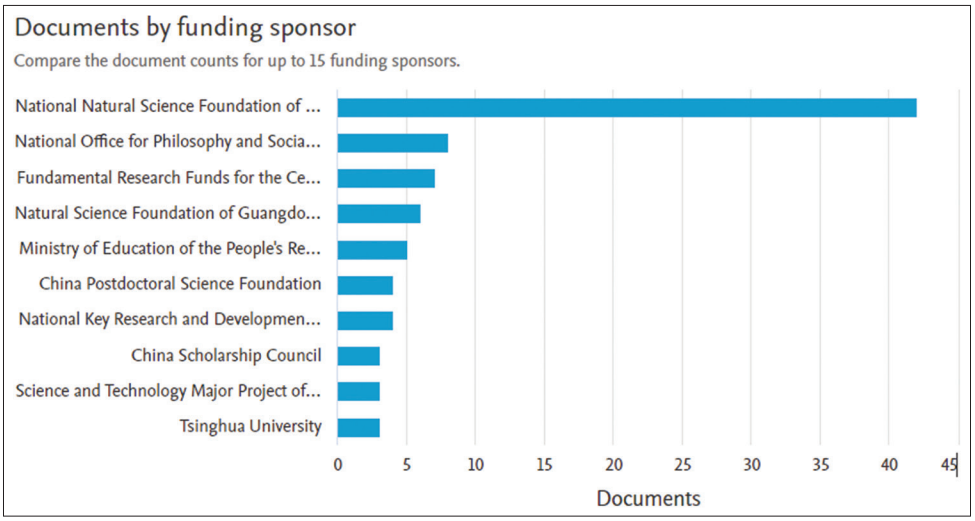
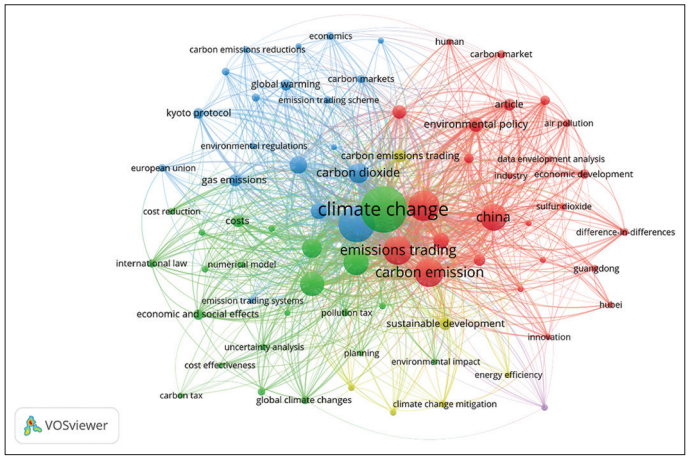


Figure 9: Network representation of keyword co-occurrence



4.7. Analysis of Funding Sponsor

Figure 8 lists the top 10 funding sources where the most significant publications on CET and climate change have been made. As can be seen, with more than 42 publications supported, the National Natural Science Foundation of Technology took first place in terms of financing sponsors.

The publisher National Office for Philosophy and Social Sciences was the next. Eight publications are sponsored by the basic research funding.

5. BIBLIOMETRIC ANALYSIS OF THE MAIN TOPICS THE DATA SET COVERS

In this section, the most important topics from our dataset will be examined. The most frequently used words by authors were examined. The 171 articles' substance and the important climate change and CET subjects that were covered are discussed in some detail by the keyword analysis.

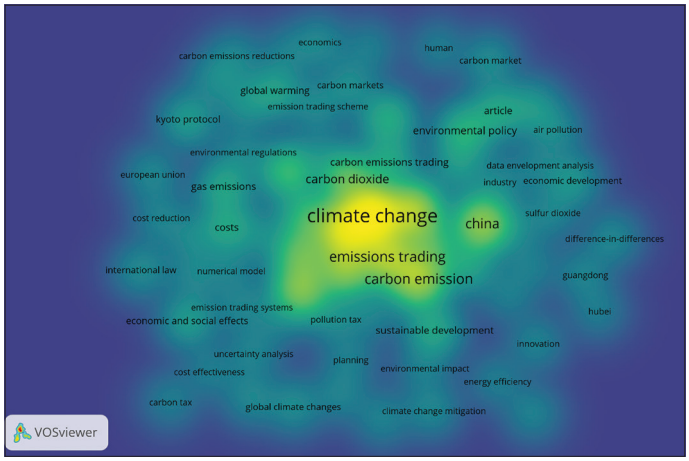
Co-occurrence of keywords analysis is used to evaluate the connections between the key topics in the investigated area (Ji et al., 2018). Which areas of study on CET and climate change were connected is shown by the data in Table 1. It determines

Table 1: Top 20 co-occurrences of keywords

No.	Keywords	Occurrence	Total link strength
1	Climate change	114	851
2	Emission control	78	648
3	Carbon	60	533
4	Carbon emission	55	488
5	Emission trading	55	471
6	China	49	422
7	Commerce	45	360
8	Carbon emission trading	42	299
9	Carbon dioxide	32	281
10	GHGs	26	255
11	Carbon emissions	31	237
12	Environmental economics	22	214
13	Carbon trading	23	213
14	GHG	18	182
15	Article	15	175
16	Environmental policy	20	174
17	Gas emissions	20	135
18	Emissions trading scheme	15	130
19	Sustainable development	16	128
20	Carbon emissions trading	16	114

GHG: Greenhouse gas

Figure 10: Cluster visualization of keyword co-occurrence



the co-occurrences of keywords across the network. The words "CET," "climate change," "emission trading," "carbon emission," and "carbon dioxide" were appropriately processed by hand. We also only consider words that appear in the list at least five times.

"Climate change" is the most popular search word, and it's closely related to "emission control," "carbon," "carbon emission," and "emission trading." The strongest relationships are seen in the keywords climate change, emission control, carbon, carbon emission, and emission trading, as shown in the network map of keyword co-occurrence (Table 1). Network representation of keyword co-occurrence in Figure 9 as follows:

The phrases climate change, emission trading, carbon emision, carbon dioxide, CET, environmental policy, and industrial economic development are some of the most crucial ones, according to network visualization (Figure 10). According to the network visualization, the three most prominent terms were carbon emissions, climate change, and emission trading.

The most prevalent parameters (for example, most influential authors, highly productive countries, most referenced documents, sources, authors, and highly prolific institutions) are explored by combining type of analysis and unit of analysis variations. Using the most prevalent terms used in the field, the largest group of related things is given.

6. CONCLUSION

The primary goal of the study is to identify academic studies that help decision makers decide whether climate change adds value to their organization's carbon trading emission. This is done by analyzing and visualizing the relationship between the keywords "climate change" and "emission trading" in the Journal of Technological Forecasting and Social Change. Thus, from 2001 to 2022, this report evaluated global research advancements in carbon emission pricing and climate change published in the Journal of Technological Forecasting and Social Change. Based on a sample of 171 papers, this study. Over the past 5 years, there has been extensive research on the subject of CET and climate change. Most notably, the volume of publications has increased significantly after 2018. The primary research areas according to WOS categories may be separated into business, management, business finance, and economics based on the co-keyword network analysis. As time went on, the journal's chronological theme steadily evolved along with the burgeoning studies on CET and climate change. The articles on carbon emission trade in particular combined the subjects of climate change, carbon emissions, and emission trading in that order. As a result, it can be seen in the literature that over time, climate change becomes a factor in CET. Additionally, the question of how CET relates to climate change has been addressed in the literature. The literature timeline also shows the topic's concentrated time frame, which runs from climate change to CET.

Tsinghua University is the institution that has contributed the most articles to the field. The results of the bibliometric analysis revealed contributions and gaps in this study, with China being the most influential nation and the topic being organized into four clusters: IC, Climate Change, Emission Trading, Carbon Emission, and Carbon Dioxide. It is appropriate to highlight the paper's originality because hitherto unprocessed themes are handled in a distinctive manner. Additionally, for the first time in timeline dynamics, a broad range of the most cited authors, co-authors, scientific fields, universities, and nations are displayed with visual interpretation. The fact that bibliometric analysis has been developed while drawing influence from PRISMA, however, has to be clarified. A META analysis cannot be performed since there are only 171 pieces of available data. This can be recognized as a study restriction. The value added by climate change to CET is analyzed in the study planned for the aim of portrayal by virtue of the conclusions made by the literature review on various databases. It is anticipated that it will serve as a guide for decision-makers who monitor trending themes on climate change in order to benefit the company. because bibliometric analysis has been specifically chosen.

Bibliometric analysis is a technique for analyzing and comprehending scientific publications that makes use of

quantitative measurements. The methodology is based on the idea that patterns and trends in the literature can provide important details about the state of a certain field, such as its development, research trends, and significant actors (Donthu et al., 2021). It is a scientific computer-assisted review procedure that looks through all the papers connected to a particular subject area and may identify noteworthy research or authors, as well as their link. In order to understand the entire intellectual environment, the bibliometric analysis can provide sufficient and related data on the topic (Han et al., 2020). Identification of gaps in the literature is done via bibliometric analysis. This can help researchers find neglected or understudied fields of inquiry. Finding potential partners can be done through bibliometric analysis. This can be done by looking at co-authorship patterns and finding authors and organizations having a history of working together (Santa Soriano, 2018).

Bibliometric analysis can be used to find potential sources of financing for research. This can be achieved by looking at the funding sources of recent research and identifying potential financing organizations and programs active in a certain field. Research significance can be assessed using bibliometric analysis (Van Leeuwen et al., 2001). This can be done by analyzing citation patterns and identifying the most-cited works in a particular field. Overall, bibliometric analysis is a flexible method that may be used to highlight significant trends, players, and opportunities for future research as well as to give a quantitative and objective image of a study subject (Nicolaisen, 2010). Future research directions in CET and climate change are possible. Sector-based climate change criteria and CET components are the subject of topic model and content analysis. Similarly, to open Emission Trading, Emission Trading Systems, Economic and Social Effects, Gas Emissions, Environmental Policy, and Environmental Regulations. We identify the following possible future study directions when considering both concepts:

The popular subjects in this research area from 2001 to 2022 are shown in Figure 10. With search phrases of frequency 100 and lower, subjects like carbon capture and storage and clean development mechanisms began to trend. After 2016, the search keyword frequency for CO_2 mitigation increased significantly, reaching 150 and beyond. This is related to the fact that many scholars were looking into the Paris Agreement, which had been finalized the year before. The study's trending subjects right now include carbon emissions, thermal efficiency, solar energy, decarbonization, climate change, and CET. The top searches from 2005 to 2022 provide insight into the significance that researchers have given to low-carbon growth research and carbon emission trading. Researchers claimed that these popular search terms had been investigated between 2015 and 2021 (Doda et al. 2021; Feng et al. 2021; Hájek et al. 2019; Zhang 2015) in order to uncover several findings, such as how the carbon emission trading policy has encouraged energy and conservation, thereby lowering CO2 emissions in China, even at the pilot stage, and Europe as a whole. Future studies could look into how carbon emission trading is impacted by climate change in several sectors, including industry, healthcare, and others (Duan, Y., Ji, T., Yu, T. (2021b).

Overall, there are many possible research areas in the fields of climate change and CET, and both will likely continue to grow as long as economic and social repercussions continue to alter how businesses collaborate and compete (Dutta, A.,2018). As a result, good practices that businesses can use to advance the development of carbon emission trading are demonstrated. To share information and experience, obtain access to new climate change, carbon emission trading, and innovation, organizations should develop strategic relationships with other organizations, universities, and research institutions (Hache, E., Palle, A. (2019). Creating a data-driven culture: Businesses should create a culture that allows them to make decisions based on data (Elango, B. (2019); Fang, K.,et al.,2017). This can be done by making investments in data analytics technologies, training staff members in data analytics, and fostering an environment that values data-driven decision-making. Analyzing how climate change affects employee motivation and engagement reveals that it has an impact on how employees operate and generate value (Forliano, C., De Bernardi, P., Yahiaoui, D. (2021). Future studies could look into how these changes affect employee motivation, engagement, and performance.

The performance of a single journal can be assessed using bibliometric analysis when it comes to the research's constraints. The validity of a single journal can be evaluated using bibliometric analysis, however there are some restrictions to be aware of. One drawback of bibliometric analysis is that it relies on quantitative measurements, like citation counts, which ignore the caliber of the research. As a result, bibliometric analysis by itself might not give a full picture of a journal's reliability. Additionally, bibliometric analysis is based on the amount of citations a manuscript receives, which might vary depending on the journal's standing, the subject matter, and the passage of time after publication. Bibliometric analysis can be used to assess the performance of a particular journal, but it is crucial to take into account its constraints.

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