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Examining the Relationship between Economic Growth, Financial Development, and Carbon Emissions: A Review of the Literature and Scientometric Analysis

Umar Nawaz Kayani[1]*, Misbah Sadiq[2], Mustafa Raza Rabbani[3], Ahmet Faruk Aysan[4], Farrukh Nawaz Kayani[5]

[1]College of Business, Al Ain University, Abu Dhabi, United Arab Emirates, [2]College of Business Administration, Umm Al Quwain University, United Arab Emirates, [3]Department of Accounting and Finance, British University of Bahrain, Kingdom of Bahrain, [4]Hamad Bin Khalifa University, College of Islamic Studies, Qatar Foundation, Qatar, [5]Director Finance & Accounts, Saffron International, Islamabad, Pakistan. *Email: umar.kayani@aau.ac.ae

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ABSTRACT

This article presents a comprehensive overview of the relationship between economic growth, financial development, and carbon emissions by utilizing bibliometric analysis and scientific mapping. The research utilized the Scopus database, covering the period from 1989 to 2023. Through network analysis, the study identified five primary clusters, distinguished by the geographical and technological extent of the topic. The main objective of this review is to provide a comprehensive understanding of the future research avenues in the nexus between economic growth and carbon emissions. The article discusses the authors, journals, regions, and organizations that have had a significant impact on the growth-emission nexus, along with a summary of the most frequently cited works in this field. Furthermore, a meta-analysis was conducted to determine the aggregate impact of each research initiative. Based on the analysis and identified gaps, the study proposes future research paths.

Keywords: Economic development, Carbon footprint, Economy-carbon nexus, Environmental Quality, Financial growth, Pollution
JEL Classifications: Q56, Q59, B22

1. INTRODUCTION

The most significant environmental challenge of the 21st century is global climate change, which is also a topic of discussion among scientists, legislators, and environmental activists. People's priorities have evolved away from short-term growth and towards long-term socio-economic and environmental development as a result of the adoption of sustainable development in this scenario (Streimikis and Baležentis, 2020). Researchers have initiated an investigation into the variables and costs associated with the destruction of the environment. The rising concentration of greenhouse gases, the majority of which is composed of carbon dioxide (CO_2), is recognized as one of the most important contributors to the phenomenon of climate change. Financial development is an important driver of economic growth and overall national prosperity (Aysan et al., 2020; Kayani et al., 2017; Song et al., 2021). The growing standard of living has led to an increase in energy use, which has a negative impact on the natural environment (Yumashev et al., 2020). The expansion of economic activity is directly correlated with increases in both the demand for energy and the deterioration of the surrounding environment. The improving level of life implies that more funds are available to spend on items that have an effect on the environment, such as increasing the number of credits that are available for the use of damaging kinds of energy. The interaction between increased economic activity and environmental degradation poses a danger to the continued existence of all kinds of life on Earth (Thangaiyarkarasi, 2021).

Carbon dioxide emissions have serious consequences on environmental quality. The causes of pollution and ecological

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damage have been the subject of a great deal of research (Jiang and Khan, 2022; Liu et al., 2022). Although the link between financial development and carbon emissions is still unclear in the current research, economic growth is another factor that influences emissions. Recent research has only briefly touched on the connections between commerce, economic growth, and ecological sustainability (Iqbal et al., 2020; Khan et al., 2021). The results showed a correlation. Hence it is safe to assume that financial development is bad for green growth in the long run. As a result, more individuals are being pushed to invest in energy-intensive technologies that degrade environmental quality and drive-up emissions nationwide (Thangaiyarkarasi, 2021). Very few research found the reverse to be true. Considering these results, it is clear that progress in the financial sector is key to bringing the economy to a sustainable level (Tsaurai, 2020). The green technology, financial systems, and low-carbon economic policies they are proposing and embracing are helping to slow down environmental destruction (Cheshmehzangi, 2021; Louche et al., 2019).

One of the Sustainable Development Goals (climate action) is environmental protection. Improvements in financial development in the aforementioned economies have a positive effect on environmental quality and performance, according to unique research on A.S.E.A.N. nations (Malaysia, Indonesia, Thailand, Vietnam, and the Philippines) (Rasiah, 2018). Research results indicated that green and low-carbon economies may be maintained with the help of policies that promote renewable energy and environmental responsibility (Cheshmehzangi, 2021). The government of Singapore actively promotes and implements policies that help foster a green economy (Li et al., 2022). Although development is necessary for economic growth, it may have negative effects on ecological quality. Due to this, Vietnam has established nation wide targets for cutting carbon emissions (Shem et al., 2019). In addition, governments all around the world, including those in Europe, Asia, and Oceania, are making efforts to reduce their emissions of greenhouse gases by supporting green technology and green businesses (Osman et al., 2022; Simionescu et al., 2022).

Australia is using green technology to lessen its impact on the environment and promote sustainability. Economic and social indicators show rising performance, whereas environmental ones show a downward trend (Khanal, 2021). Although it may be difficult to analyse all the factors of emissions in China, the nation is by far the world's greatest contributor of carbon dioxide. Abbasi et al. (2022) and Pata (2021) discovered that although using fossil fuels increases CO_2 emissions, using renewable energy sources helps reduce the negative effects of this problem. In an effort to grow in a way that does not harm the environment, Malaysia has adopted green policies. The Malaysian government and economy are both taking steps to protect the planet (Ali et al., 2016). Although Myanmar is working to allay environmental concerns about climate change, even Indonesia has taken the first steps towards adapting to a green, low-carbon economy (Gong and Balazs, 2021).

The research is important in a variety of different ways. The term "financial inclusion" refers to one aspect of the wider idea of "financial development." The results of the research are critical for building a consensus on the effect of financial development on the green environment, which is necessary for policymaking in favour of a sustainable environment. The research makes contributions in the following ways. According to the authors' best estimates, it contributes to the existing body of knowledge by discussing the function of financial development while taking into account emissions of carbon dioxide as an indication of environmental quality or performance. Second, the current research contributes new information to the ongoing discussion on financial development. Academics and researchers have not yet reached a decision regarding whether financial development contributes to the deterioration of the environment or whether or not it helps to improve the environment. Using an innovative bibliometric technique, the research investigates the third question of whether or not economic growth may be considered a control factor for carbon emissions.

The remaining parts of the article are organised as shown below. The research methods that were used in Section 2 to better comprehend the notion are discussed in further detail. In section 3, the findings and their specific discussion are covered, while Section 4 presents future research directions. Section 5 concludes the research.

2. DATA AND METHODOLOGY

The intellectual research structure and contribution of a particular field of study to development of science can be analyzed using a variety of techniques (Donohue, 1972; Khan et al., 2020; Nobanee, 2021). These methods include Systematic Literature review (SLR), Meta analysis, Scientometric analysis and Bibliometric analysis (Abubakar and Aysan, 2022; Abubakar et al. 2022; Aysan et al., 2021; Khan et al., 2021). Systematic Literature Review is the qualitative way to identify, synthesize and analyze the overall findings of a research to make comparison and draw the conclusion (Aysan and Nanaeva, 2022; Aysan and Ünal, 2021; Rohman et al., 2021; Kayani et al., 2019). Meta analysis is more of an empirical technique to combine the overall findings of a group of study to a given set of problems to make comparisons and find the overall direction of the research (Aysan et al, 2022; Singh et al., 2020; Khamis and Aysan, 2022). Scientometric analysis is a quantitative method to examine the development of research based on its citation relationship, mapping the knowledge area and future research trends (Hassan et al., 2022; Aysan and Ünal, 2021). Bibliometric analysis is the most widely adopted review technique in the last decade or so. It is a technique assisted by the technology to measure the performance of a subject and its core theme by identifying the most prolific authors, countries, affiliation, journal performance, collaboration pattern, and research constituents. Bibliometric analysis is used to explore the intellectual and social structure of a specific domain in the extant literature (Bashar et al., 2021; Hassan and Raza Rabbani, 2022; Naeem et al., 2022). Current study used bibliometric analysis to know the intellectual structure between the economic growth, financial development and carbon emission. The study also intends to know the major research trends, future scope of the study and intellectual structure using review of various research in the domain and network technique (Kayani et al., 2022). Bibliometric analysis is the most widely adopted technique due to its ability to

rigorously explore and analyze the large volume of data (Hassan et al., 2022; Wasiq et al., 2023).

The present study presents its findings in two steps. The first consists of the findings obtained using 'biblioshiny' software of the R-package. The results from the biblioshiny are presented in the form of the most prolific authors in terms of number of documents and citations, most prolific countries, journal and institutions contribution to the financial development and carbon emission domain. The study also used VOS viewer application to graphically demonstrate the data in network form. VOS viewer presents the network to analyze the co-citation, co-occurrence, bibliographic coupling to find out the research theme in the financial development and carbon emission domain (Basher et al., 2022; Rabbani et al., 2022).

The study used obtained data from the Scopus database as it is the largest abstract and citation database for social science research (Rabbani et al., 2021). A combination of keywords was used to extract the data. The keyword included TITLE-ABS-KEY to extract the studies related to the financial development and carbon emission. The used keywords were., "economic growth", "financial development", "carbon emission", "CO_2 emission", etc. (TITLE-ABS-KEY ((financial AND development) OR (economic AND growth)) AND TITLE-ABS-KEY ((carbon AND emission) OR (CO_2 AND emission))).

The search used inclusion criteria to include studies published only in English language and with a period spanning 2009 to 2023. The first search using the mentioned keywords resulted in the First search results in 12731 research articles. Out of which 1358 conference papers, 614 review articles, 510 book chapters and 67 books were removed, and the remaining 10,003 articles were further investigated manually to get a final sample of 1268 articles. The manual investigation is a tedious process to analyze each article by its title, abstract and keywords to know the central theme of the article selected is based on the financial development and carbon emission. The Table 1 shows the summary statistics of the final sample of data used for analysis.

Table 1: Data characteristics

Description	Results
Main information about data	
Timespan	2009:2023
Sources (Journals, Books, etc.)	423
Documents	1268
Annual growth rate %	13.92
Document average age	4.82
Average citations per doc	25.38
References	66162
Document contents	
Keywords Plus (ID)	5152
Author's Keywords (DE)	3273
Authors	
Authors	3305
Authors of single-authored docs	179
Authors collaboration	
Single-authored docs	189
Co-Authors per Doc	3.3
International co-authorships %	30.39
Document types	
Article	1268

The final dataset consists of the 1268 articles published in the various journals. It can be observed that the average age of the document is 4.82 years whereas, the average citation per document is 25.38, which indicates high citation in the energy economics domain. These studies were published by 423 sources with an annual growth rate of 13.92. Author collaboration reveals that there are 189 single authored documents and 3.3 authors per document. International collaboration percentage is 30.39.

3. RESULTS ANALYSIS AND DISCUSSION

The findings from the bibliographic evaluation are shown below. In this section, we describe the attributes of the sample, the number of scientific papers published each year, the rate of publication growth, the top journals, the top authors, the top documents, the top sources, the top organizations, the top countries, the top affiliations, the top words, the co-citation assessment, and the cartography evaluation. The selected study streams are discussed in length, and the path that research will take in the future is outlined.

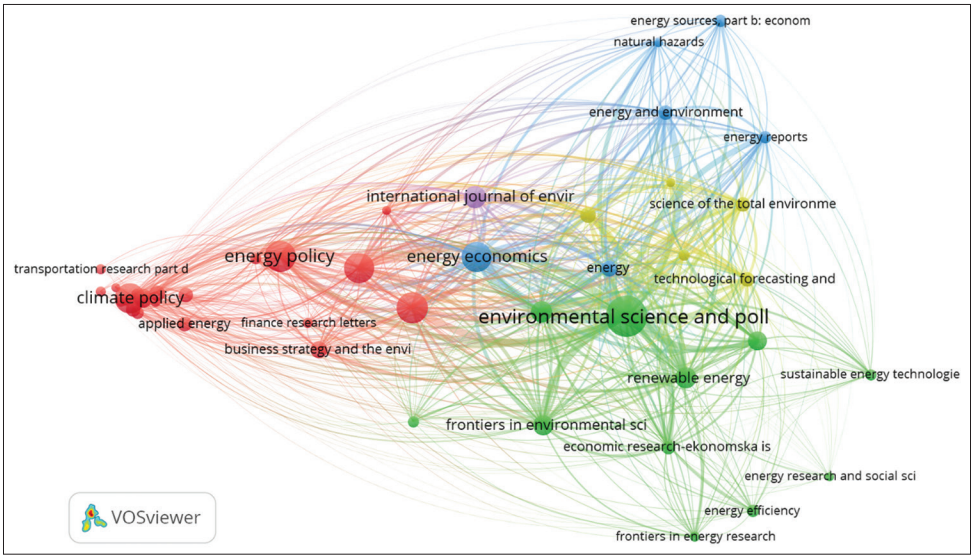
3.1. Annual Scientific Production

The annual scientific publication gives a trend analysis of publishing activity on the topic that is being studied throughout the course of time. Figure 1 shows the yearly scientific publication that was produced between the years 1989 and 2023. According to the statistic, the number of copies published has increased at an exponential rate throughout the course of the years. Despite the fact that the first publication on the topic under investigation was published as early as 1989, the academic community throughout the world did not start paying serious attention to it until the year 2004. By 2004, it can be seen that there were some years when no study was published on this topic. In the year 2004, there was just 1 article published, however this number rose to 3 in 2005 and then there was constant increase which was initially at a slow rate till 2008. In 2009, there were five publications on this topic, and from that year forward, there has been an upward trend in this regard. In the early stages of the research, the primary emphasis was placed on topics such as financial subsidies lead to energy consumption, role of economic growth on environmental quality, EKC, energy efficiency and sustainability The research on economic growth-emission nexus in the latter part of the previous decade (the 2010s) focuses primarily on the application of sustainable green technologies, and in the field of renewable energy finance. From 1989 through 2023, it represents the yearly scientific publication. From a mere 1 to 328 in 2022, the number of papers covering the relationship of economic growth and financial development on carbon emissions increased dramatically (Table 2).

3.2. Most Cited Articles

Table 3 shows that citations per year for the selected articles and their citable years. The average article citations per year item show a gradually increasing trend form 1989 peaked in around 1993, then again showed a dip in 1995, later in 1999 and then in 2004. After 2004, there has been a sharp increase in this value with three peaks, first in 2009 with a mean TCP per year of 6.44, then in 2015 with a mean TCP per year of 6.6 and finally in 2019 with a mean TCP value of 8.54. The item citable years with refers to the

Figure 1: Relavent citation sources map generated by VOS viewer



mean number of times that papers published in a certain calendar year are referenced during that year has been seen to decline 35 in 1989 to only 1 in 2023.

3.3. Most Relevant Journals and Authors

It is essential for the bibliometric research to identify the sources that are most pertinent to the topic that is being investigated in order to provide readers with a map of the journals that are considered the most reputable in regard to the amount of articles published and citations that they have received from the research world. According to Table 4, which can be found below, Environmental Science and Pollution Research, which is published by Springer, is the most prolific journal when it comes to publications targeting the economic growth and pollution nexus. This journal has compiled the maximum number of articles i.e., 90 than any other journal in this field and has a total of 281 local citations. Energy Policy, by Elsevier Publishers, has published the second-most articles i.e., 54 with the higher citation score of 2431 followed by Journal of Cleaner Production also published by Elsevier which has published a total of 53 articles on this topic. Figure 1 shows the relavent citation sources map generated by VOSViewer.

Table 5 presents the top 20 most relevant authors who have contributed the most to the field of economic growth and its impact on emission levels. The top most relevant author in this list is Li. who has published 18 articles and has an articles fractionized score of 6.42 followed by Chen et al. with a total of 13 publications each.

3.4. Most Relevant Affiliation

The most important contributing affiliations and organizations that are actively engaged in the research and analysis of the nexus between financial development and carbon emissions are shown in Figure 2. The School of Management and Economics has produced the most papers on this topic. Most of the papers published as part of this affiliation are targeted on the areas of economic development and carbon footprint and the EKC concept in developing and developed countries. Next in the list is the China University of Mining and Technology situated in Beijing China publishing a total of 37 articles on this topic followed by Jiangsu University Zhenjiang, China with the total number of 34 articles.

Table 2: Annual publication volume on economic growth and carbon emission nexus

Year	Articles
1989	1
1990	0
1991	0
1992	2
1993	1
1994	1
1995	1
1996	0
1997	0
1998	2
1999	1
2000	2
2001	2
2002	2
2003	0
2004	1
2005	3
2006	4
2007	7
2008	19
2009	17
2010	34
2011	38
2012	32
2013	48
2014	46
2015	44
2016	50
2017	64
2018	79
2019	96
2020	105
2021	145
2022	338
2023	84

Table 3: The citation scores of publications from 1989 to 2023

Year	MeanTCperArt	N	MeanTCperYear	CitableYears
1989	2	1	0.06	35
1992	24.5	2	0.77	32
1993	49	1	1.58	31
1994	13	1	0.43	30
1995	9	1	0.31	29
1998	44	2	1.69	26
1999	4	1	0.16	25
2000	22	2	0.92	24
2001	29.5	2	1.28	23
2002	10	2	0.45	22
2004	1	1	0.05	20
2005	75.33	3	3.96	19
2006	68	4	3.78	18
2007	20.57	7	1.21	17
2008	37.95	19	2.37	16
2009	96.53	17	6.44	15
2010	29	34	2.07	14
2011	52.08	38	4.01	13
2012	23.47	32	1.96	12
2013	58.54	48	5.32	11
2014	26.37	46	2.64	10
2015	59.39	44	6.6	9
2016	38.5	50	4.81	8
2017	31.3	64	4.47	7
2018	36.39	79	6.07	6
2019	42.7	96	8.54	5
2020	30.66	105	7.66	4
2021	20.1	145	6.7	3
2022	6.75	338	3.38	2
2023	0.65	84	0.65	1

Table 4: Most relevant journals on the topic of economic growth and carbon emissions

Sources	Articles	Citations
Environmental Science and Pollution Research	90	281
Energy Policy	54	2431
Journal of Cleaner Production	53	354
Sustainability (Switzerland)	48	16
Climate Policy	47	280
Energy Economics	47	429
International Journal of Environmental Research and Public Health	28	26
Energies	25	185
Renewable Energy	25	129
Frontiers in Environmental Science	22	7
Resources Policy	19	51
Environmental Research Letters	16	41
Business strategy and The Environment	15	138
Climatic Change	14	4
Energy	13	4
Journal of Environmental Management	13	82
Applied Energy	12	128
Energy and Environment	12	22
Ecological Economics	11	1
Plos One	11	80

3.5. Geographical Distribution

The Figure 3 shows the geographical distribution of the publications in shades on blue. The darker the shade, the higher the publication volume. From this map, it can be seen that the highest of volume of articles have been published from China i.e., 1378. Other regions with maximum work in this area include UK, USA and Australia. The regions in brown have no scientific

Table 5: The top 20 most relevant authors in this field

Authors	Articles	Articles fractionalized
Li J	18	6.426190476
Chen Y	13	3.258333333
Wang J	13	4.05
Wang X	13	3.176190476
Wang Y	11	3.141666667
Zhang Y	11	3.219298246
Li X	10	3.95
Liu Y	10	3.092857143
Zhang X	10	3.316666667
Li S	8	2.183333333
Li Y	8	2.058333333
Liu X	8	2.616666667
Liu Z	8	2.533333333
Wang F	8	2.191666667
Wang H	8	2.535714286
Wang Z	8	2.126190476
Yang L	8	2.016666667
Chen S	7	1.783333333
Chen W	7	2.702380952
Khan A	7	1.703968254

Figure 2: Most contributing affiliations in the research and analysis of the nexus between financial development and carbon emissions

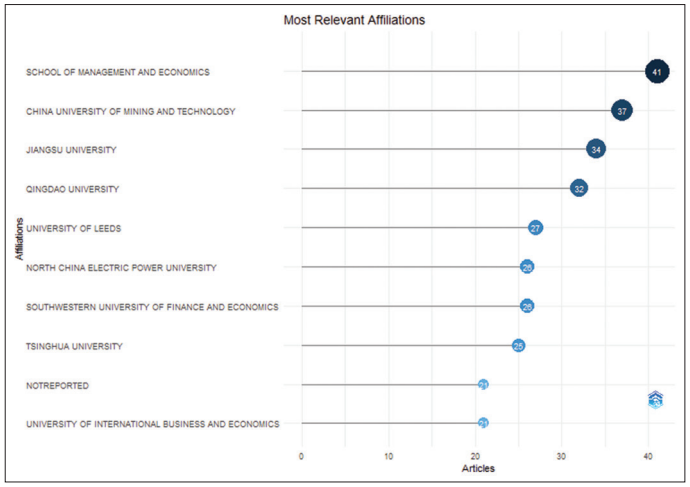
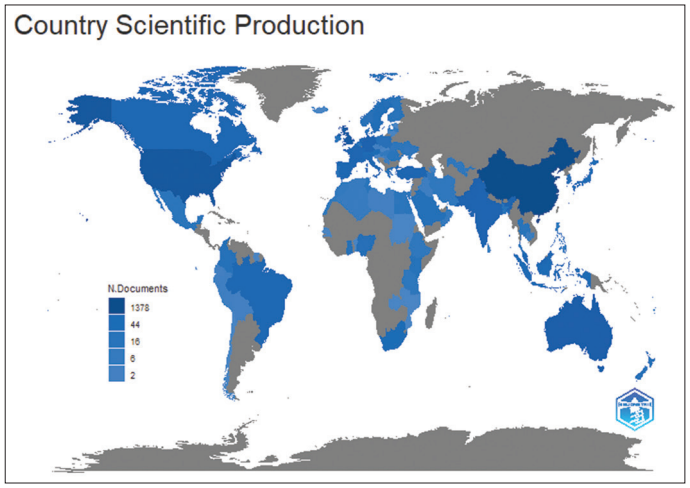


Figure 3: Geographical distribution of the publications



contribution in this area yet. Table 6 presents the top 20 countries of the world with the highest total and average citations. It can be noted from the data presented that highest total citations are attributed to China with an average article citation score of 19.5. Next in the list is USA with total citations of 2641 followed by UK with a number of 2386. Figure 4 shows the geographical distribution map utilizing VOSViewer.

3.6. Keyword Occurrences Analysis

The research trend in financial growth's impct on carbon emissions may be clarified with the use of a keyword occurrence trend by taking a look at the term that is used by authors, in the title, and in the abstract, the most often. This analysis is helpful in recognizing the top areas of research status as well as the rising pathways of scientific curiosity in certain fields of study. Other researchers have employed approaches quite similar to ours in order to determine the developing patterns and thematic progression of the research streams. In order to investigate the fundamental concepts associated with the sustainable economic development, we carried out a keyword and keyword occurrence analysis. Words like "carbon dioxide," "finance," "carbon emission," "climate change," "carbon," "economic development," "environmental economics," and "sustainable development," as well as "environmental policy," "economics," and "investments," are some of the most frequent keywords that are displayed in Table 7, along with their total frequency. The highest frequency is of carbon dioxide i.e., 556 followed by finance i.e., 531.

The word cloud that was generated via the use of the R-Studio program is shown in Figure 5. A word cloud is, in its most basic

Figure 4: VOSViewer map presenting the geographical distribution of studies

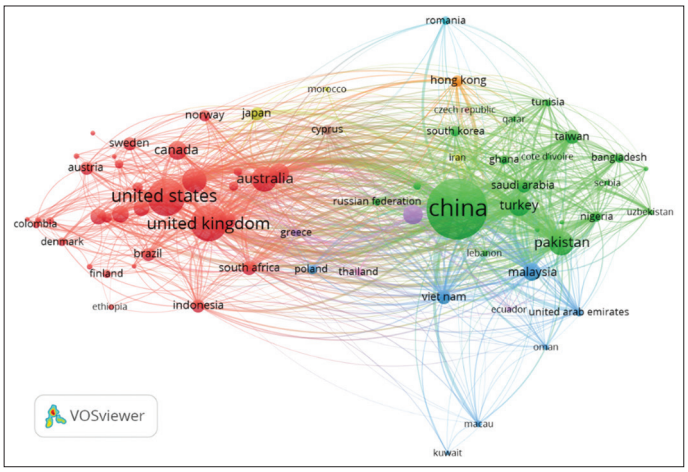


Table 6: The top 20 countries of the world with the highest total and average citations

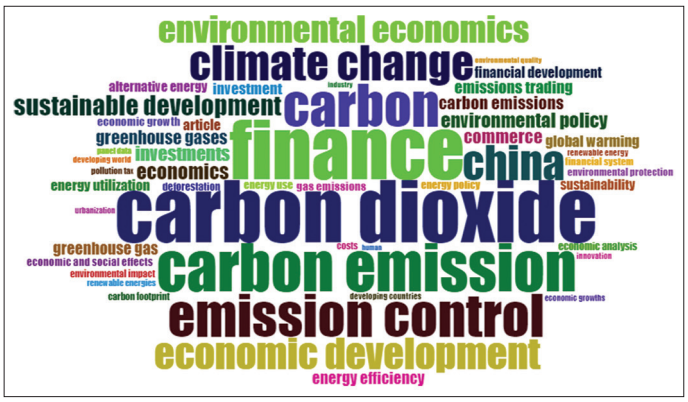
Country	TC	Average article citations
China	7526	19.5
USA	2641	28.7
United Kingdom	2384	26.8
Australia	1699	44.7
Spain	1675	76.1
Pakistan	1607	67
Turkey	1567	71.2
India	904	41.1
Netherlands	747	41.5
Germany	723	17.2
Canada	642	26.8
Malaysia	534	33.4
France	459	14.3
Qatar	457	228.5
Switzerland	429	28.6
Korea	347	28.9
Denmark	317	63.4
Japan	304	27.6
Sweden	270	27
Nigeria	251	20.9

Table 7: Keyword occurance and frequency

Terms	Frequency
Carbon dioxide	556
Finance	531
Carbon emission	430
Emission control	382
Carbon	380
Climate change	315
China	312
Economic development	282
Environmental economics	243
Sustainable development	181
Economics	143
Environmental policy	135
Investments	131
Commerce	126
Greenhouse gases	122
Carbon emissions	120
Emissions trading	112
Greenhouse gas	112
Energy efficiency	111
Investment	106
Global warming	104
Energy utilization	98
Article	97
Financial development	97
Sustainability	93
Alternative energy	92
Gas emissions	83
Economic growth	82
Economic and social effects	77
Energy use	76
Energy policy	75
Deforestation	73
Economic analysis	72
Environmental protection	71
Financial system	71
Costs	66
Environmental impact	66
Carbon footprint	65
Pollution tax	59
Renewable energies	59
Developing countries	58
Developing world	58
Renewable energy	58
Innovation	57
Economic growths	56
Panel data	56
Urbanization	55
Environmental quality	52
Industry	51
Human	49

form, a graphical representation of the text data. In other terms, it is also referred to as the collection of words or cluster of words that are shown in the various sizes. The tag is a single word, and it is used to symbolize the cloud. The significance of a word in the cloud is shown by its magnitude relative to the other words. The largest size of the tag in Figure 4 is carbon dioxide, which indicates that carbon dioxide is found the most often in the keyword and title searches. This is shown by the fact that it has the largest size of the tag.

Figure 5: R-Studio word cloud for keyword occurance



The keyword co-occurrence map extracted by utilizing VOSViewer is shown in Figure 6. In the literature on the topic of study, the terms "carbon dioxide," "finance," "carbon emission," "climate change," "carbon," "economic development," are used the most often. The clusters of one color represent the keywords that are used together in research.

3.7. Co-citation Analysis

The citation network is a guided network that reflects the citing of one researcher's work by the other. It also depicts the pooling and exchange of knowledge as well as the overall influence that scientific study has had on the topic. VOSviewer is used to generate a citation network of writers, which is then shown in Figure 7. The requirements for inclusion in the network are as follows: each author must have a minimum of 2 publications, and each of those documents must have earned a minimum of 5 citations.

As can be seen in Figure 7, the newly constructed citation map is divided into five distinct groupings. The red cluster represents authors who have referenced one another's work in the field of financial development-carbon emission nexus, and their research has focused mostly cost benefit analysis, energy efficiency and optimization. In the network map, the second cluster is coloured green and has a total of 16 different writers. These academics are

Figure 6: VOSViewer keyword co-occurrence map

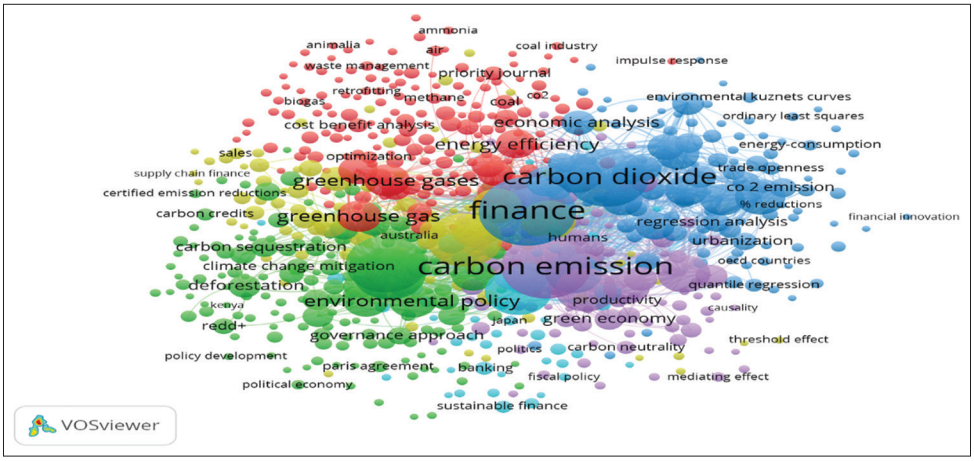


Figure 7: VOSviewer citation network map

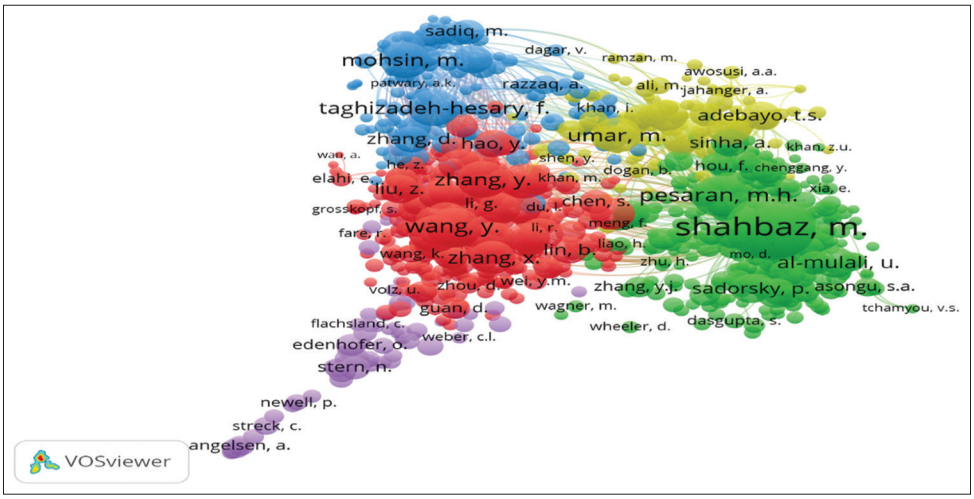
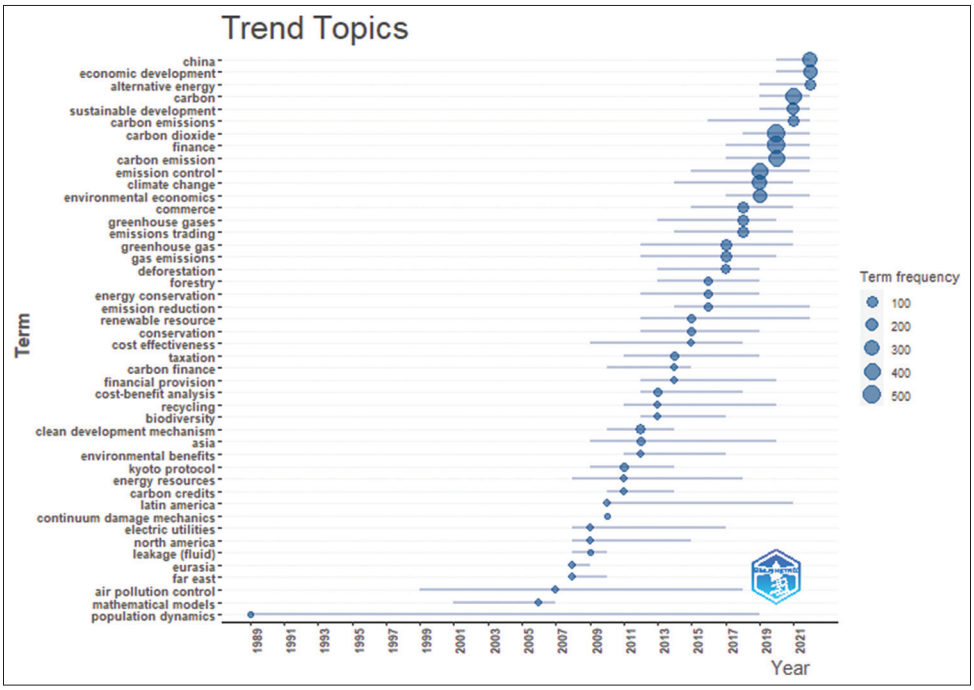


Figure 8: The frequency of major topics in the field of economic growth and carbon emission nexus and their distribution over years from 1989 to 2023



familiar with one another's work and often cite it when discussing carbon nuetrality and sustainable finance. The blue-colored cluster includes a total of 8 authors who have worked together to investigate the EKC, financial innovation and % reductions.

3.8. Topic Trends

Figure 8 presents the frequency of some major topics in the field of economic growth and carbon emission nexus and their distribution over years from 1989 to 2023. According to the Figure, the topic with the highest frequency is carbon dioxide. However, with reference to the years distribution, the topic with the highest stretch in terms of years is population dynamics spanning from 1989 to 2019. However, the frequency value of this topic is 5.

4. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

In conclusion, the link between economic growth, financial development, and carbon emissions is a complicated and diverse issue that has gained substantial attention from academics and politicians in recent years. This is because of the many facets that make up this relationship. Some important discoveries about this issue have been uncovered because of our review and bibliometric analysis of the relevant literature. First, most experts agree that a flourishing economy and expanding financial sector lead to more pollution. When economies expand, their energy demands rise, as do their emissions of greenhouse gases. Large-scale infrastructure projects or the rise of extractive industries are two examples of how financial development might make it easier to fund endeavours that could otherwise increase carbon emissions. Yet, there is not a simple connection between GDP growth, improved financial systems, and increased carbon emissions. The effects of a flourishing economy and expanding financial system on carbon emissions are complicated and nuanced. The use of renewable energy sources like wind and solar power, for instance, may aid in cutting down on carbon emissions even as they contribute to economic development. Carbon taxes and cap-and-trade systems are two examples of policy interventions that have been shown to encourage businesses to decrease carbon emissions while maintaining profitability.

The ramifications of our research for public policy are significant. Financial growth's beneficial effect on carbon dioxide emissions may indicate that businesses choose to increase output through financing rather than create energy-saving solutions. This should cause policymakers to pause and think about the potential environmental costs of expanding the banking sector. Long-term policies should be developed to assist the financial sector and environmental conservation, striking a balance between the two goals in light of each country's unique circumstances and the global climate change crisis. Thus, governments should prioritise allocating resources for cultivating technical growth in the industrial sector, like giving loans for investments that create goods with reduced carbon emissions and supporting initiatives related to renewable resources. Using this route has the potential to lessen the burden on the environment by increasing energy productivity. Additional options include granting subsidies for the implementation of "green" technology or encouraging the growth of energy output from renewable sources like hydro, solar, and wind. As a result, governments should prioritise policies that combine financial incentives with regulatory measures to reduce carbon dioxide emissions. As a preliminary step, developing the capabilities for trustworthy information collection and analysis is necessary so that national institutions can establish precise estimates of emissions and projections under different mitigation scenarios. Coordination between government agencies, think tanks, academic institutions, and businesses is the next step

needed to effectively execute the mitigation methods. A carbon tax and carbon allowances that may be traded might be two of the most effective policies. Meanwhile, banks and other financial organizations need to lead the charge to save the planet. For those who can implement energy-efficient technology, for instance, they may be able to provide low-interest loans.

Studies have shown that there is a complicated web of interconnections between GDP growth, financial development, and carbon emissions. While some research indicates a positive relationship between economic growth and financial development and carbon emissions, other studies suggest a potential inverted U-shaped relationship between economic growth and carbon emissions (Destek et al., 2020), with emissions rising alongside economic expansion but levelling off after a certain threshold is crossed. The link between GDP expansion, monetary advancement, and greenhouse gas emissions may be studied in a number of different ways in the future.

Further study is required to determine the effect that advances in technology have on lowering carbon emissions while simultaneously fostering economic expansion and monetary growth. For instance, a decrease in greenhouse gas emissions may result through the introduction of smart grids and electric automobiles (Adetunji et al., 2020). In addition, developments in technology for renewable energy might assist nations in shifting away from fossil fuels and towards cleaner energy sources, which would be a positive development. In the future, studies might potentially investigate the possibility of synergies between other technologies, which would further boost the effect of these technologies. While a large number of research have been conducted to investigate the connection between economic growth, financial development, and carbon emissions in certain nations, there is still a need for further comparative studies. This kind of analysis might be helpful in identifying parallels and variations in the techniques followed by various nations and areas to encourage sustainable economic development while simultaneously lowering carbon emissions. Comparative research might also assist in identifying the most effective policies and procedures, which would then enable other nations to foster long-term economic development more effectively. More study on the efficacy of policy interventions in lowering carbon emissions while simultaneously fostering economic growth and financial development is required. Policy interventions such as carbon taxes, cap-and-trade systems, and subsidies for renewable energy are just a few examples (Chen et al., 2020) of the kinds of things that may be investigated in further detail. The potential for policy initiatives to have unexpected repercussions, like increasing inequality or having a detrimental influence on some sectors or areas, is another topic that might be investigated in more study in the future.

As climate change is a problem that affects the whole planet, there is a pressing need for more study on the role that international collaboration plays in solving the problems of striking a balance between economic development and environmental sustainability. The influence of international accords, such as the Paris Agreement, on the reduction of carbon emissions and the promotion of sustainable economic development may be the subject of study that will be conducted in the future (Wang and Su, 2020). In addition, studies might investigate the possibilities for international collaboration to ease the flow of technological know-how and experience from industrialised to underdeveloped nations. Financial institutions, such as banks and insurance firms, play a significant part in the process of lowering carbon emissions and fostering environmentally responsible economic development. In the future, research might investigate the influence that green finance efforts, such as sustainable investment funds and green bonds, have on the rate of carbon emissions reduction and the promotion of sustainable economic development (Ning et al., 2022). In addition, studies might investigate the possibility of financial institutions using their power to encourage environmentally responsible behaviour among the businesses in which they have invested. The field of study that pertains to the connection between economic growth, financial development, and carbon emissions might go in a great many different directions in the future. Researchers may discover solutions for supporting sustainable economic growth while simultaneously tackling the issues posed by climate change if they investigate these subjects in more detail and come to the same conclusions. In the end, this kind of study may help advise corporate leaders and governments on how to build a future that is more sustainable for everyone.

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