

A Bibliometric Analysis of Research Trends to Study the Impact of Financial Development on the Environment

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Abstract

The present study is an attempt to dwell into the area of financial development and to understand its impact on the environment and sustainability. Using the meta-data of 628 research articles from the period of 2009-22, the analysis begins with a description of the sample dataset retrieved from the Scopus database. The research advances concerning the thematic and intellectual structure of different aspects of financial development and the environment are examined. Using the bibliometric methodology of scientific mapping, a cluster analysis based on bibliographic coupling of documents is undertaken. The results reveal four emerging themes. Using content analysis, the impact of Financial Development (FD) on 'Carbon Emissions,' 'Environmental Quality,' 'Energy Consumption,' and 'Environmental Degradation' is presented in four subsections as clusters. The findings of this study are expected to provide valuable assistance to future scholars in their investigation of the phenomenon pertaining to these four specific sub-areas.

Keywords: Bibliometric Analysis, Climate Change, Environment, Financial Development, Sustainability, Vosviewer

JEL Classification: Q50, O19

1. Introduction

Financial development is measured by the growth of the banking sector¹⁻³, private credit growth^{4,5}, money supply growth⁶, bond market development and financial efficiency indicators⁷. It is a measure of how much the financial sector has broadened and widened in an economy. Literature has extensively examined

the environmental effects of financial development in connection to the carbon emissions generated over time by various economic sectors. This more comprehensive idea, often known as the carbon footprint⁸, includes emissions from both industrial and non-industrial sources. Transportation, agriculture, household energy consumption, and other activities that increase carbon emissions may all fall under this category. The level of

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energy consumption, which is a direct precedent of carbon emissions⁹ has also been considered as a crucial indicator of environmental health. The long-term impact of carbon emissions is attributed to climate change as discussed since the 1997 Kyoto Protocol and has always been a matter of the global warming debate ever since⁹.

Pieces of evidence of environmental deterioration in the form of CO₂ emissions, rising sea levels, and heating of the planet are profound. In COP 21 (Conference of Parties), the Paris Agreement was adopted by 196 nations to form a treaty to address and act for the mitigation of climate change by primarily focusing on reducing global warming¹⁰. The latest COP 26 yielded the 'Glasgow Climate Pact' which calls upon financial institutions to play a significant part by providing financial resources to address the current world climate conditions. COP 26 also developed building blocks for advanced-level implementation of the Paris Agreement for the creation of a low carbon-emitting and sustainable world¹¹.

Past studies have focused on the impact of economic development and consider financial development to be complementary to the former¹². A large number of studies measure and confirm that the relationship between financial development and the environment is significant, however, three distinct viewpoints exist regarding its impact, i.e., some studies show that financial development positively impacts the environment¹³⁻¹⁷, some show negative impacts¹⁸⁻²¹, and rest report that it has no impact on environment^{22,23}. Therefore, there is no clear consensus on whether financial development improves or degrades the environment.

The present study interprets the advancement of literature in the field of financial development and environment. This study is an attempt to identify, encapsulate, stitch together and create a nucleus of the latest developments and trends in the area of financial development and its impact on the environment. The study also highlights the emerging areas by dividing the literature into meaningful clusters. Since the meta-data available in this area is widely spread and scattered, there is a need to identify and examine the dynamic nature of the ever-evolving results, to create a direction for the future. Therefore, to achieve this objective and gain insights from the meta-data, bibliometric analysis is found to be a suitable approach, as it helps in bridging these gaps.

The study has four sections After the initial discourse, Section 2 delves into the study's aims and the methodology adopted, encompassing the criteria utilised

for the screening and selection of papers. In Section 3 the data analysis and findings derived from the bibliometric analysis are presented. The components encompassed within this framework consist of a country collaboration map, keyword analysis, citation analysis, and clustering methodology based on bibliographic coupling. Section 4 of the document provides a comprehensive summary of the findings and implications, as well as a discussion on the limits of the study. Additionally, it outlines potential avenues for future research.

2. Objectives of the Study and Research Methodology

The primary objective of this study is to analyse the research trends and implications of financial development on the environment. The following sub-objectives are designed to support the achievement of the main objective:

- To examine the current trends in financial development as it pertains to the environment.
- To identify the thematic areas and key topics in research related to the impact of financial development on the environment.
- To explore the network structure of citations and examine keywords to uncover emerging areas of research in the intersection of financial development and the environment.
- To develop a comprehensive roadmap for future research, guiding the relationship between financial development and its environmental impacts.
- Based on the above research objectives, the following questions need to be answered:
- RQ1: What are the current publication trends concerning the relationship between financial development and the environment?
- RQ2: Which specific areas of research are currently being explored in the field of financial development and its impact on the environment?
- RQ3: How is the network structure of studies related to financial development and the environment organised?
- RQ4: What insights can be derived from the analysis to inform future research endeavours in the field of financial development and the environment?

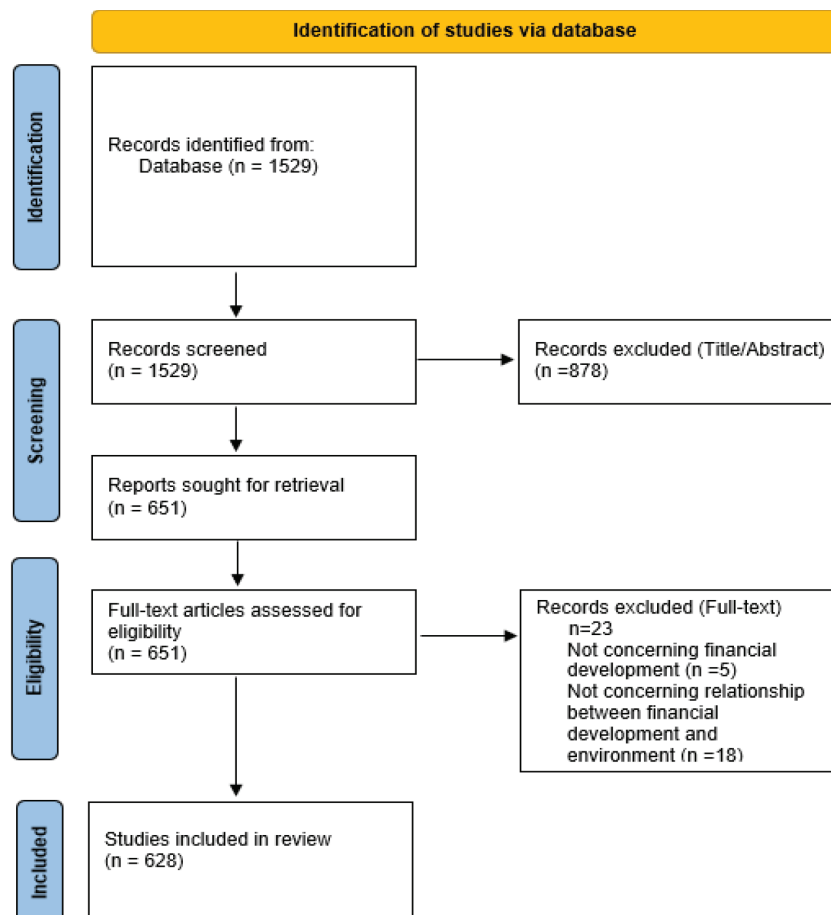
The study seeks to establish a coherent framework for examining the influence of financial development on

the environment and to provide insightful information for future research in this field by aligning the research questions with the stated objectives. The selected method for answering the research questions and achieving the study's goals is bibliometric analysis. First, it makes it possible to examine publishing patterns (RQ1) through the analysis of bibliographic information. This entails gauging the volume of papers produced over time, identifying influential writers, and analysing the distribution of publications among various journals. Second, the study can pinpoint the precise areas of research that have attracted a lot of attention by examining the keywords and substance of the articles (RQ2). It also highlights new fields of study, pointing out gaps and possible directions for further research. The investigation of citation networks is also made straightforward by bibliometric analysis (RQ3). The study's ability to identify important works and comprehend the relationships and partnerships between scholars and research groups is

made possible by looking at the patterns of citation found in pertinent publications. By demonstrating how concepts and knowledge have spread and evolved in the context of financial development and environmental changes, this approach sheds light on the intellectual structure of the discipline. Finally, bibliometric analysis aids in the creation of a thorough roadmap for future research (RQ4) by synthesising the outcomes of the earlier studies.

2.1 Database Selection, Identifying Keywords and Eligibility Criteria

To collect data for systematic review, the PRISMA framework is employed²⁴. Inclusion criteria were as follows: (a) inclusion of articles concerning the impact of financial development on the environment (b) inclusion of articles from subject areas: environment, economics, energy, social science, management and multidisciplinary



Source: Author's compilation
Figure 1. PRISMA flowchart.

(c) inclusion of articles published between 2009-22 (d) English manuscripts were included.

For this study, the Scopus database is used because it contains International Scientific Indexing (ISI) and Scopus-indexed articles²⁵. Scopus database was searched using a combination of keywords (“Financial Development”; AND “environ*”; OR “natur*”; OR “climat*”; OR “sustain*”; OR “carbon*”; OR “Energy consumption”; OR “ecolog*”), in the title, keyword or abstract which returned 1529 articles.

Figure 1 describes the PRISMA flowchart for filtering and selecting the final data for further analysis.

Screening: The identified articles were screened by reading the title, and abstract and checking with the objective of the study and excluded 878 articles. 219 articles were not related to financial development. 659 articles did not deal with the relationship between financial development and environment. The screening resulted in shortlisting 651 documents.

Eligibility: The eligibility of the 651 articles was assessed by reading the full text. All authors independently prepared a list of possible articles for this review. Disagreements among authors were discussed and resolved by consensus during this step. After reading the full text 23 documents were excluded, which were not in line with the objective of this review.

Inclusion in review: Finally, 628 documents were included for the bibliometric analysis.

2.2 Bibliometric Analysis and Visualisation

The study employs R Studio for conducting the bibliometric analysis and visualisation. R Studio is a free and open-source software and bibliometric analysis can be undertaken through its library “Bibliometrix”. This analysis tool allows the user to conduct scientific mapping of the data. The library “Bibliometrix” directs the user to a web interface called “Biblioshiny,” which allows the user to visualise and analyse the data. It provides descriptive analysis of the publications (journals, authors, institutions, and cross-country collaboration), citations, and keywords. Keyword analysis is a valuable tool for uncovering the central concepts, emerging themes, and ideas within a specific research area. In this regard, the keyword plus method is employed in Biblioshiny to extract relevant keywords that provide structural knowledge and capture the broader aspects of the field. For inferential thematic analysis, a bibliographic coupling method is used to create clusters of the citations together.

VOSviewer software is used for creating clusters based on bibliographic coupling. Therefore, at the next step, by using “R Studio” and “VOSviewer”, 628 documents are scientifically mapped to describe the various trends in research as well as visualise various thematic areas that are emerging from these documents. As a last step, the results are presented in the form of tables, figures, and clusters. This helps reveal the various trends and issues significant to the area of study and is expected to aid in future research.

3. Data Analysis and Findings

Results from the bibliometric analysis, which includes trends in publishing, collaboration, citation, and keyword analysis are presented as follows.

3.1 Publication Trends

The descriptive analysis of the chosen data is displayed in Table 1. The temporal scope of the dataset spans from 2009 to 2022, encompassing a total of 150 periodicals and 628 articles as primary sources. The table additionally presents the various document formats, the average citation counts, relevant keywords, authors’ contributions to the creation of the piece, and their collaborative endeavours. The chosen time frame of 2009-22 for this analysis was arrived at post a thorough search, utilising pertinent keywords, and applying stringent filtering, which found that the articles that fit the study goals were primarily published within this timeframe. Moreover, the selection of this specific timeframe ensured that the study was able to consider the most relevant and up-to-date scholarly works pertaining to the topic at hand. The past decade has been widely recognised as a period characterised by heightened worldwide awareness of environmental issues. Consequently, there has been a proliferation of legislation aimed at addressing these concerns, rendering the field of environmental consciousness a dynamic and ever-evolving domain. Therefore, to have a comprehensive understanding of the current state of knowledge, it is essential to concentrate on recent publications. Hence, using a recent time frame guaranteed that the study considers the most recent advancements in financial development and its effects on the environment.

Figure 2 shows a sharp rise in recent research on the relationship between financial development and the environment, showing increased interest in the topic. Global conventions, agreements, and diplomatic gatherings, such

Table 1. Descriptive Analysis of Documents

Description	Results
Timespan	2009:2022
Sources (Journals)	150
Documents	628
Citations count (each doc.)	43.18
Average citations per year per doc	10.45
References	31416
Document Types	
Journal Articles	628
Document Keywords	
Identified	1547
Declared	1083
Authors	
Total	1368
No. of Documents with only one author documents	62
Authors Collaboration	
Single-authored documents	69
Average no. of authors (Each Doc.)	2.18
Collaboration Index	2.34

Source: Author's compilation using Biblioshiny

as the crucial Paris Agreement of 2016, have had an impact on this expansion. The increase in the number of studies shows a greater understanding of the connection between economic development and environmental sustainability, offering information for governments, financial

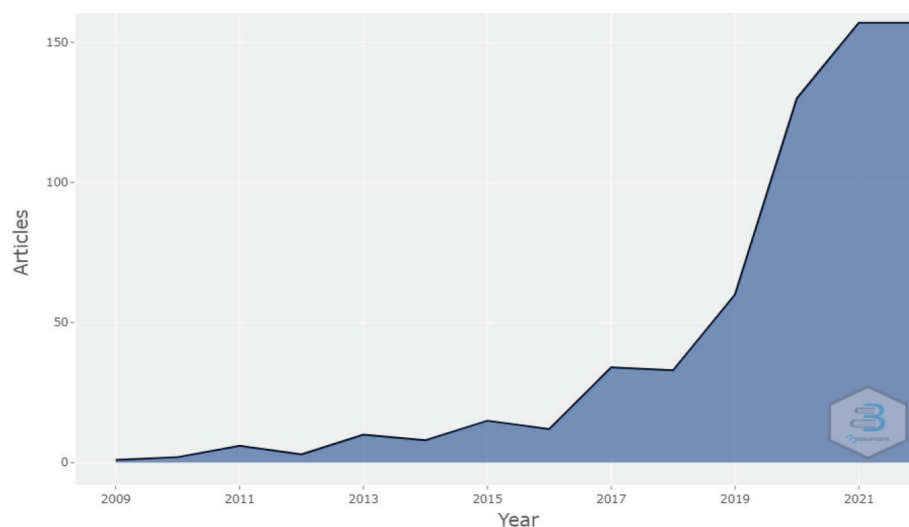
institutions, and enterprises to make wise decisions. In the financial industry, it also denotes a need for creative responses to environmental problems, opening doors for potential in sustainable investing, green financing, and enhanced resource management²⁶.

3.2 Bradford's Source Arrangement

The statistical analysis of the literature data reveals that not all 150 sources used in the study are equally significant. Although the impact factor is frequently used to gauge the quality of a source²⁷, it is unable to account for the regularity, continuity, and concentration of articles within a journal. Using journals that generate at least one-third of the articles in the literature as a starting point, Bradford's Law, another strategy, finds essential sources²⁸. Only three of the 150 journals - Environmental Science and Pollution Research, Resources Policy, and International Journal of Energy Economics and Policy, together publish 231 articles out of the whole dataset of 628 articles (Table 2). As seen in Figure 3, this means that these three journals are of the highest importance in terms of Bradford's Law. The significance of these publications in the field of study is highlighted by this insight, which suggests that scholars should pay close attention to the contributions and conclusions in these Journals.

3.3 Country Collaboration

Figure 4 depicts the country's collaboration map, which gives insights into the country's collaborative efforts in terms of publication production. According to the map,



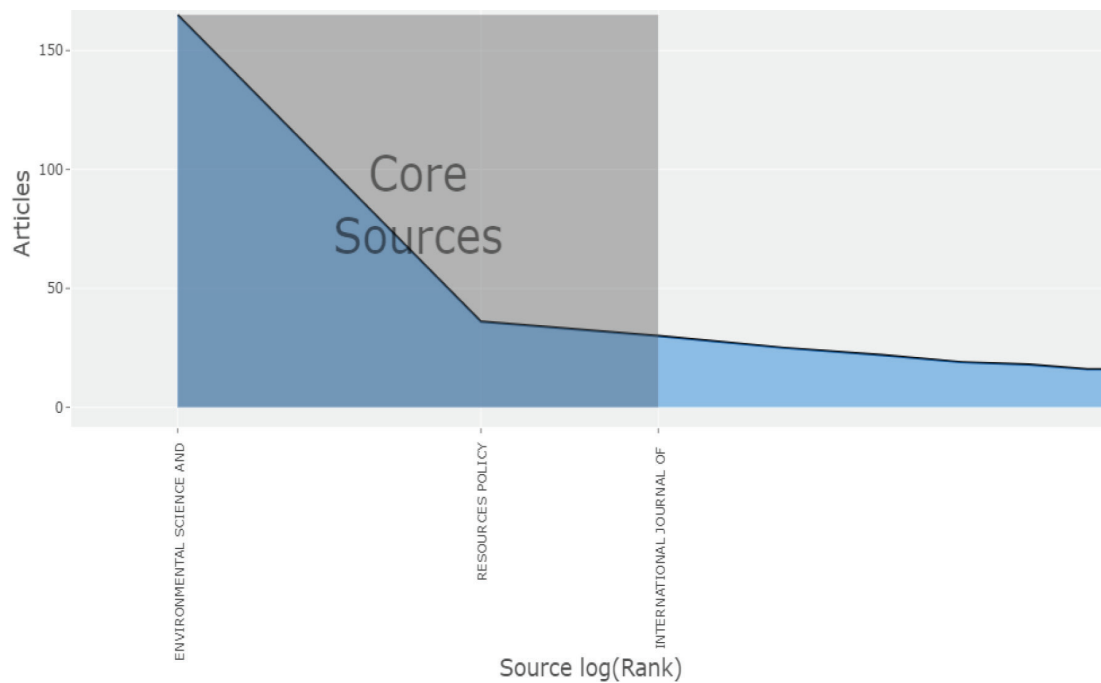
Source: Authors' illustration using Biblioshiny

Figure 2. Annual Scientific Production.

Table 2. Journal Ranking based on Bradford's Law

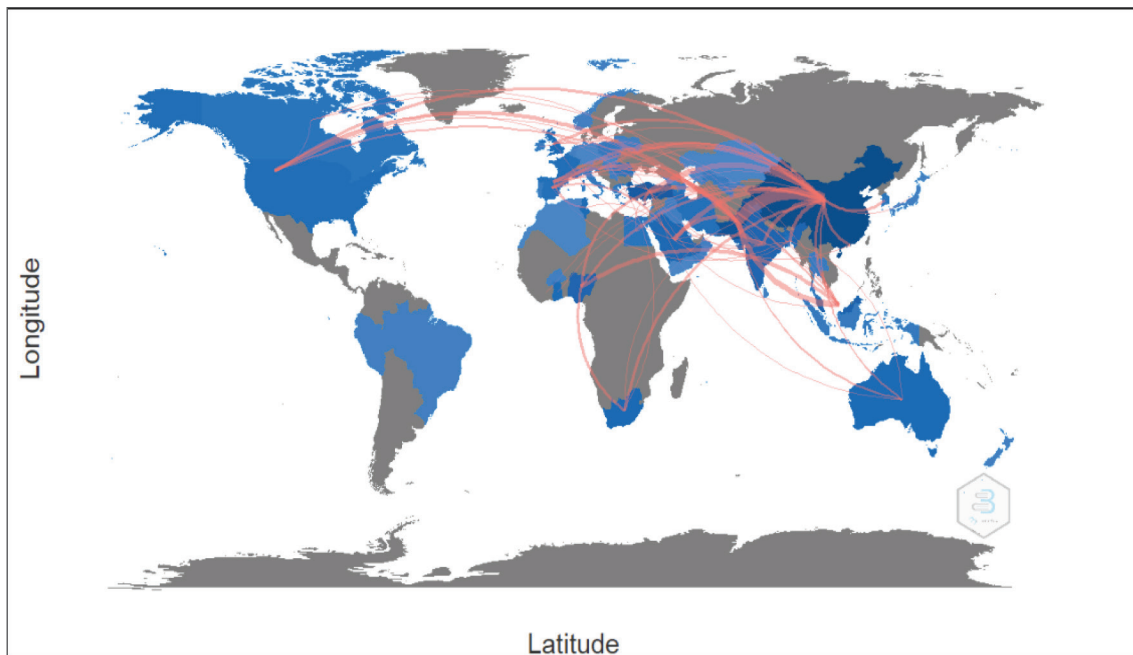
Sources	Rank	Frequency	Cumulative Frequency	Zone
Environmental Science and Pollution Research	1	165	165	Zone 1
Resources Policy	2	36	201	Zone 1
International Journal of Energy Economics and Policy	3	30	231	Zone 1
Sustainability (Switzerland)	4	25	256	Zone 2
Energy Economics	5	22	278	Zone 2
Renewable Energy	6	19	297	Zone 2
Journal of Cleaner Production	7	18	315	Zone 2
Energy	8	16	331	Zone 2
Energy Policy	9	16	347	Zone 2
Energies	10	14	361	Zone 2
Journal of Environmental Management	11	14	375	Zone 2
Frontiers in Environmental Science	12	10	385	Zone 2
International Journal of Environmental Research and Public Health	13	10	395	Zone 2
Energy Reports	14	9	404	Zone 2
Energy Sources, Part B: Economics, Planning and Policy	15	8	412	Zone 2
Environment, Development and Sustainability	16	7	419	Zone 2
Management of Environmental Quality: An International Journal	17	7	426	Zone 2
Business Strategy and the Environment	18	5	431	Zone 3
International Journal of Social Economics	19	5	436	Zone 3
Journal of Public Affairs	20	4	440	Zone 3

Source: Authors' compilation using Biblioshiny



Source: Authors' illustration using Biblioshiny

Figure 3. Ranking of journals as per Bradford's Law.



Source: Authors' illustration using Biblioshiny

Figure 4. Country Collaboration Map.

China has the highest level of collaboration, as evidenced by the largest production size among all countries. China's significant position shows a strong emphasis and active involvement in financial development and environmental research. China's leadership in financial development and the environment originates from the country's fast economic expansion, knowledge of the need for sustainable development, and dedication to tackling environmental issues. Its worldwide relevance as a significant emitter of greenhouse gases, along with investments in research, international collaboration, and institutional support, drives its strong participation in this sector. India, like China, has made substantial joint efforts in this sector. The darker colour shades on the chart imply larger production sizes, suggesting countries that have made significant contributions to the literature. The findings highlight the need for international collaboration in furthering research and comprehending the intricate financial development and sustainability connections. They also emphasise the opportunity for countries to share best practices and exchange information to address environmental concerns through effective finance systems. The collaborative activities illustrated in the map offer useful insights for policymakers, academics, and institutions looking to foster multidisciplinary

collaboration and create beneficial environmental results through financial development programmes.

3.4 Citation Analysis

Citation analysis is important for identifying the most cited documents because they are found useful and insightful by other authors. A research study is cited by other researchers due to its novel contribution to the area of study. Normalised Total Citations (NTC) account for differences in citation rates of publications and give a relative assessment of a paper's effect and influence within a certain context. It enables a fair comparison of the citation performance of various articles, taking into account criteria such as publication year and field of study. A higher NTC number shows a paper's greater effect or influence when compared to the dataset's or period's average citation count.

Table 3 describes the top ten most cited documents. Tamazian *et al.*,²⁹ is the highest-cited document with 753 citations. These findings suggest that research into the link between financial development, energy consumption, commerce, urbanisation, and environmental concerns, notably CO₂ emissions, is an important and active topic of research. The high citation rates and NTC values also reflect the intense interest in comprehending the intricate interaction of economic

Table 3. Top 10 Most Cited Documents

Paper	Total Citations (TC)	TC per Year	NTC
Tamazian <i>et al.</i> , 2009 ²⁹	753	53.786	1
Ozturk & Acaravci, 2013 ²³	721	72.1	2.7126
Sadorsky, 2010 ³⁰	641	49.308	1.0864
Jalil & Feridun, 2011 ¹⁵	634	52.833	1.6518
Pao & Tsai, 2011 ³¹	610	50.833	1.5892
Dogan & Turkekul, 2016 ²²	592	84.571	5.1665
Tamazian & Bhaskara Rao, 2010 ³²	539	41.462	0.9136
Zhang, 2011 ¹⁴	510	42.5	1.3287
Shahbaz & Lean, 2012 ³³	477	43.364	1.7515
Shahbaz <i>et al.</i> , 2013 ¹⁶	435	43.5	1.6366

Source: Authors' Compilation using Biblioshiny

expansion, financial systems, urban growth, and their environmental consequences.

3.5 Keyword Analysis

The top ten keywords selected using this technique are shown in Table 4, with “economic development” appearing as the most often occurring term with a frequency of 497. Among the discovered keywords, “carbon dioxide” and “financial development” are also prominent.

These findings have important consequences for field researchers. For starters, the frequent use of “economic development” shows that it is central to the research topic’s discourse. Future research should explore investigating the relationship between economic development and the topic under consideration. Similarly, the prominence of “carbon dioxide” and “financial development” emphasises their relevance and prospective importance

Table 4. Top 10 Relevant Keywords

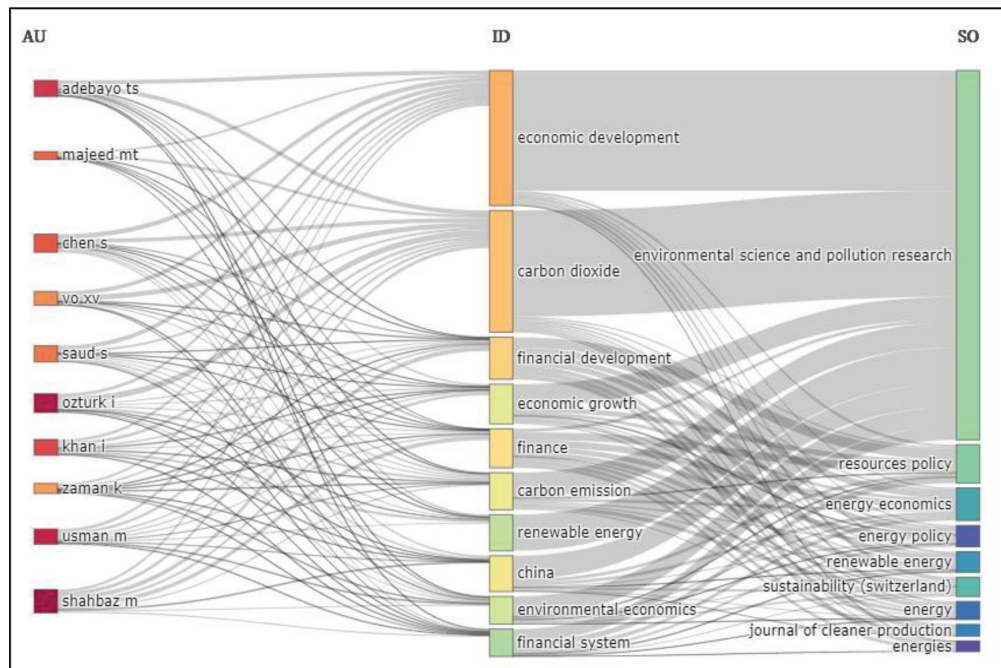
Terms	Frequency
Economic Development	497
Carbon dioxide	474
Financial Development	191
Finance	183
China	162
Carbon Emission	157
Economic Growth	157
Environmental Economics	132
Renewable Energy	125

Source: Author's compilation using Biblioshiny

in comprehending the link between these components. These selected keywords can be used by researchers to formulate research questions, design experiments, and perform literature reviews. Scholars can link their study with the field’s major themes and notions by including these terms in their investigations. This strategy ensures that their work is relevant and contributes to the current body of knowledge.

3.6 Keyword-Author-Source Plot: A Three-Field Plot

Figure 5 shows the connection between the three units of analysis (fields). The graphical representation commonly called the three-field plot or the ‘Sankey Diagram’³⁴ is a result of the connection threads between authors, keywords, and sources. Every field is connected to the other via a series of threads. Each field also has smaller components representing top authors (left field), top keywords (middle field), and top sources (right field). The flow of connection may suggest, the authors with the highest number of productions in the fields, the sub-theme or area they are working in and where that work is being published. For instance, ‘Abedeyo T. S.’ has their most cited work under the keyword ‘Economic Development’, and that work is majorly being published in the journal ‘Environmental Science and Pollution Research’. These insights allow researchers to follow influential authors and stay updated with the latest developments. Additionally, it provides information on the journals that promote research in financial development and the environment, helping researchers identify publishing opportunities and reputable sources for relevant literature.



Source: Authors' enumeration using Biblioshiny

Figure 5. Three-field Plot.

3.7 Clustering Based on Bibliographic Coupling

The study used the bibliographic coupling approach in conjunction with the VOS viewer software to conduct a rigorous analytical analysis of the content. Bibliographic coupling happens when two studies refer to the same document, forming a relationship between them. The interconnected texts can be successfully mapped and categorised by employing bibliometric coupling along with clustering³⁵, leading to a more scientifically based strategy³⁶. The use of bibliographic coupling in the analysis was motivated by its capacity to give useful insights into the linkages and interconnectivity of scholarly articles. Bibliographic coupling helps to create relationships and find theme clusters within a collection of documents by assessing shared references or citations between studies.

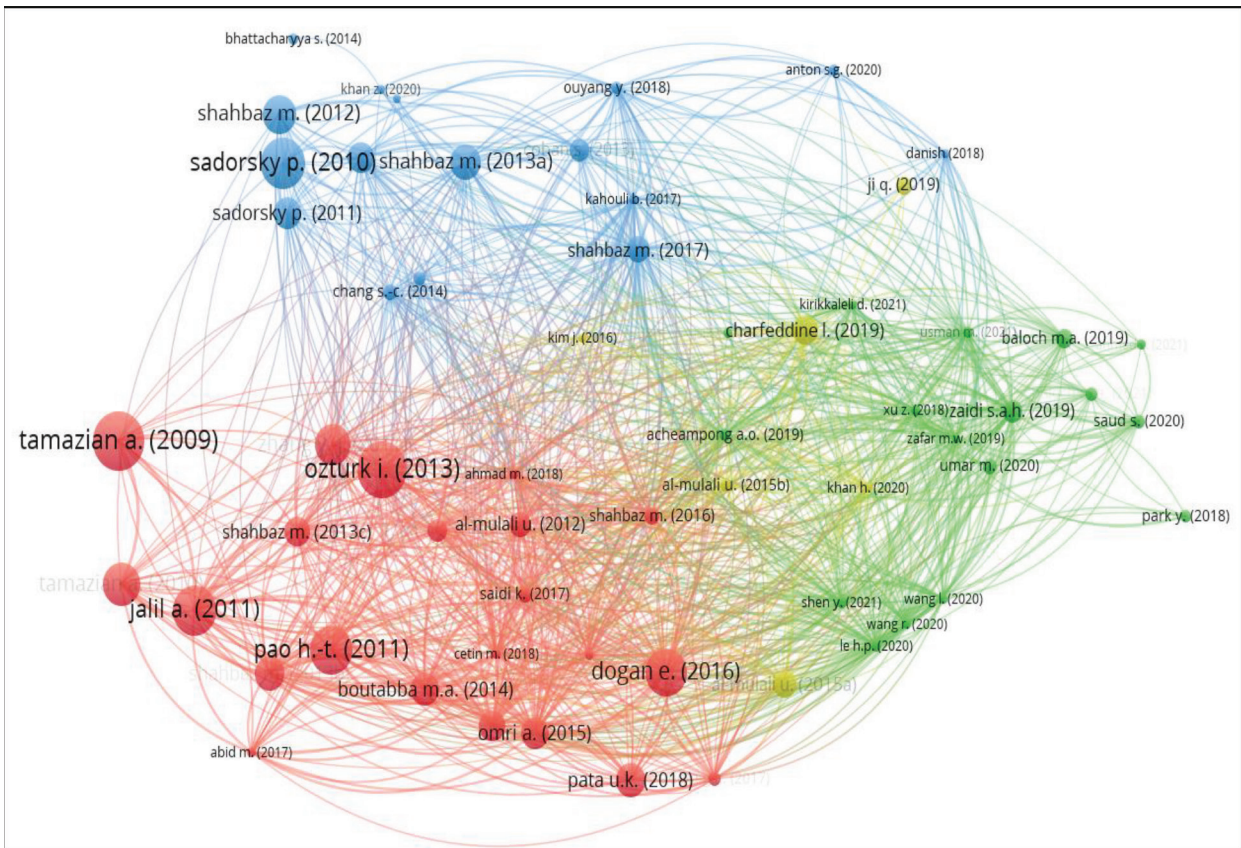
One of the fundamental motivations for using bibliographic coupling is to discover the intellectual structure and knowledge domains available in a specific topic. This helps acquire a better grasp of the significant publications and key contributions that have affected the research landscape by finding studies that reference the same texts. This helps examine the conceptual underpinnings and historical evolution of the area under

consideration. Furthermore, bibliographic coupling allows for the objective analysis of the links between distinct study fields or subjects. It helps identify unique theme clusters that reflect coherent subsets of study by grouping the interrelated texts based on their mutual references. This aids in the discovery of patterns, trends, and linkages among diverse subfields or topics within the larger realm of study.

The study was able to identify and outline four broad theme clusters within a sample of 61 papers using bibliographic coupling. These 61 papers were chosen from a wider sample size of 628 based on their considerable citation count of at least 100. The diverse clusters are represented graphically in Figure 6 by different colours (blue, red, green, and yellow) and are designated by circles. Notably, the size of each cluster represents the frequency of co-citations, whilst cluster linkages reveal the correlations that exist between them.

Cluster 1 - Impact of Financial Development on Carbon Emissions

The relationship between economic expansion and carbon emissions has been thoroughly examined in several studies^{29,32}. Recently, however, there has been an increase in research focusing especially on how financial development affects carbon emissions. In this context,



Source: Authors' analysis using Vosviewer
Figure 6. Clusters based on Bibliographic Coupling.

studies have been conducted in the US²², India¹⁸, China¹³⁻¹⁵, Russia³¹, Africa^{17,37}, the Middle East^{38,39}, and Europe³⁸. After the liberalisation of the Indian economy in 1991, the importance of financial development in reducing carbon emissions became apparent for emerging economies like India⁴⁰.

Financial development contributes to environmental deterioration by showing a consistent, causative, and long-term connection with carbon emissions¹⁸⁻²¹. While a study by Saidi and Mbarek⁴¹ affirms the monotonic (consistent and predictable) relationship between financial development and carbon emissions, they posit a negative long-term correlation, suggesting that it reduces carbon emissions and mitigates environmental degradation. Some studies on the Chinese economy^{13,14} shows a clear correlation between financial development and carbon emissions, whereas research by Jalil and Feridun¹⁵ suggests that financial development in China has resulted in a drop in carbon emissions. Similar findings have been made by independent studies carried out in South

Africa and Malaysia^{16,42}, which show that while economic expansion causes an increase in carbon emissions, financial development helps reduce them. Furthermore, it has no appreciable effect on environmental degradation in affluent nations like the US²². According to research done in Turkey, financial development has no appreciable long-term impact on carbon emissions²³.

Although research suggests that financial development may have some impact on carbon emissions. However, when we look at the wider picture, the consequences of general economic expansion and urbanisation outweigh the effects of financial development on carbon emissions¹². Instead, it has been discovered that financial development is crucial for minimising the ecological footprint, which is a gauge of how much nature is needed to sustain human activities⁴³. A strong institutional framework should be added to financial liberalisation since it is an important component of controlling carbon emissions successfully^{29,32}. The primary justification is that financial liberalisation may lead to more research

and development spending, which may help with the development of new technologies and clean, ecologically friendly manufacturing processes, hence lowering carbon emissions^{44,45}. Policymakers have a critical role in promoting sustainable practises to assure both prosperity and a decreased environmental effect, even if it is evident that financial and economic expansion result in higher carbon emissions³⁸. Energy efficiency and conservation should be given top priority by policymakers to encourage healthy economic development and a sustainable environment³⁷.

Cluster 2 - Impact of Financial Development on Environmental Quality

A strong and developed financial sector contributes significantly to the country's economic growth and improves the financial system's economic efficiency⁴⁶. An increase in economic efficiency leads to better allocation of funds and reduction of wastage. The funding of research and development in these fields, financial development is essential to increasing environmental sustainability and development of renewable energy⁴⁷. The investigation conducted by Baloch, Ozturk, Bekun and Khan⁴⁸ has revealed a significant long-term positive impact of global financial development and global renewable energy consumption on environmental sustainability. However, it is important to keep in mind that financial development may also have a negative impact on the environment by encouraging practices that cause pollution, such as manufacturing, buying cars, and installing air conditioners⁴⁹.

Numerous recent studies have looked at the relationship between financial development and environmental quality in a variety of nations, including Greece⁵⁰, China⁵¹, European Union countries⁵², and sub-Saharan African countries⁵³. Financial development has been discovered to raise CO₂ emissions, which affect environmental quality, in emerging markets and developing economies⁵⁴, Saudi Arabia⁵⁵, G7 countries⁵⁶, and N-11 countries⁵⁷. In contrast, financial development has been linked to lower CO₂ emissions and better environmental quality in economies including the European Union⁵², APEC countries⁵⁸, and OECD countries⁵⁹. However, it should be mentioned that an even more thorough indication of environmental degradation is the ecological footprint. Empirical evidence specific to individual countries presented by Saud, Chen and Haseeb⁶⁰ demonstrates that the ecological footprint increases with rising financial development in thirty countries while declining in fourteen countries due to

its influence. Similarly, countries that have signed MOUs (Memorandums of Understanding) with the Republic of China for its Belt and Road Initiative have experienced a growth in their ecological footprint with greater financial development⁴⁶.

Although studies do not reach a consensus regarding the impact of financial development on environmental quality, it has the potential to mitigate environmental degradation and improve environmental conditions by fostering investments in green technology⁶¹. By providing subsidised lending rates for energy-efficient projects and hiking interest rates for inefficient ones, the financial sector may play a significant role in this area⁵⁹. The widespread use of energy-efficient technology, such as electric cars, would be aided by such policies, which would enhance environmental quality.

Cluster 3 - Cross-Time, Cross-Country Relationship between Financial Development and Energy Consumption

Financial development is a proxy indicator of economic growth that offers information on the financial sector's performance. To gauge the progress of the financial system, researchers have used the expansion of financial intermediaries as a yardstick. Existing literature has identified various other indicators to measure the expansion of the financial sector, such as banking sector indicators¹⁻³, Money Supply^{5,6}, private and domestic credit⁵, and stock market turnover and capitalisation^{5,6,30}. On the relationship between financial development and energy use, extensive research has been undertaken. Research indicates that financial development promotes corporate growth and development through increasing financing availability⁵. Furthermore, populations frequently increase concurrently in economies that are undergoing expansion and new trends⁶². These factors collectively contribute to increased energy demand within the economy⁶³, resulting in escalated energy consumption^{5,16,63,64}.

However, it should be noted that not all financial development indicators exhibit a positive correlation with energy consumption, as evidenced by the panel study conducted by¹ among EU27 nations. In particular, the stock index, used as a gauge of financial development, had no discernible correlation with energy use. On the other hand, financial development, as an important factor, is connected to a country's total economic development³. This suggests that a healthy economy, including its financial system, draws international money and

investors, spurring additional expansion and improved effectiveness³³.

According to a study⁶², the increase in economic and financial development leads to long-term gains in the economy, which in turn leads to a decrease in energy usage. Technology developments and increased energy efficiency are to blame for this phenomenon. Tang and Tan⁶⁵ also conclude that greater income levels and financial development encourage sustainable behaviours, such as the use of renewable energy sources, investments in the research and development of green energy technology, as well as actions to conserve soil. According to Anton and Nucu², redirecting the increasing flow of funds toward sustainable technologies rather than conventional ones represents a prudent course of action enabling sustainable development.

Cluster 4 – Global Empirical Evidence Collected through Panel Data

The claim that financial development has a big influence on the environment is supported by actual data from research. According to theory, stable financial markets and favourable financing circumstances increase the likelihood of growth in the renewable energy sector⁶⁶. Considering the role of financial markets, research findings consistently indicate that financial development is associated with a reduction in CO₂ emissions⁶⁷.

However, studies focusing on the Middle East and North Africa (MENA) countries present contrasting results⁶⁸. Therefore, it is advised for these countries to enable banking loans for projects and investments that promote energy conservation, energy efficiency, and renewable energy to help these countries mitigate environmental impact in both the short and long periods⁶⁶. China, on the other hand, has major financial limitations that inexorably tie the development of its financial sector to its energy revolution. The European Union's strategy is shown as a model for China to follow by reviewing the experiences of other countries, taking precedence over the United States⁶⁹.

4. Conclusion and Implications

Studying the connection between financial development and the environment is becoming increasingly important. The rise in number of publications and their impact indicates the need for more research in this area, urging scholars to examine the numerous facets and ramifications of this relationship. Our study draws attention to the

rise in the number of scholarly publications, nations, and organisations motivated to examine how financial development affects environmental quality.

The network structure of the financial development and environmental research provides crucial information for teamwork and knowledge exchange. With respect to network structure of the journals, 3 out of the 150 journals were of utmost importance as per the methodology suggested by Bradford²⁸. The strong collaboration capacities of Asian nations (China and India) were evident in the linkages between the nations. This implies chances for international collaboration in studies pertaining to financial development and environmental protection. To better comprehend this subject, researchers may use these cooperative networks to pool resources, perform joint studies, and communicate ideas. Many of the highly cited studies from the earlier years of the time horizon were among the most cited papers^{23,29,30}. 'Financial Development,' 'Finance,' 'Economic Growth' and 'Carbon Emission' are the most frequent keywords in the literature. Researchers and practitioners looking for trustworthy information sources might get advice from the identification of important journals and widely referenced papers.

The study identified four significant themes from the literature about the different study dimensions based on the bibliographic coupling of materials. The first issue, *impact of financial development on carbon emissions*, discusses how financial development affects carbon emissions both globally and within specific regional alliances of states (such as the MENA and EU-27). Designing efficient ways to reduce environmental pollution requires an understanding of the effects of financial development on carbon emissions. The second cluster, *impact of financial development on environmental quality*, comprises of research explaining the beneficial as well as harmful effects of financial development on the environment. An improvement in environmental quality may result from investments in green technologies and energy-saving initiatives. The third cluster, *cross-time, cross-country relationships between financial development and energy consumption*, considers research on the impact of financial development on demand for energy use. High energy consumption caused by financial development in emerging nations has a harmful effect on the environment. However, in industrialised economies, it boosts environmental quality and improves the efficiency of energy resources. The final group of studies

uses global empirical evidence to examine on how financial development affects the environment. Based on the circumstances of their economies, policymakers may utilise these findings to create suitable energy laws and regulations.

The study's conclusions, including the themes and networks of collaboration that were found, might be very helpful to academics who want to delve more into this subject. The findings, highlighted gaps, restrictions, and potential future use are described in the section below. Future research can deepen our understanding of the complex relationship between financial development and the environment and lead to more effective strategies and policies for sustainable development by building on the body of existing knowledge and taking into account research themes and collaborative networks.

The research on financial development and the environment has been gaining momentum on account of global attention, academic and diplomatic conventions, and conferences on issues of carbon emission, greenhouse effect and climate change. However, the research mainly focuses on exploring and establishing the relationship (causal and otherwise) between financial development and the environment. Majority of the research is fundamental with little or no immediate application. The literature lacks the urgency of action-oriented applied research that may serve as a short and long-term roadmap and as a foundation for policy action that must be taken in the context of climate change. Therefore, the focus of the researchers should not be on exploring and establishing the relationship but rather on coming up with an evidence-based policy suggestions that can directly contribute toward a stronger institutional framework and assist the policymakers in planning and implementing effective decisions in the right direction.

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