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Article

Financial Development and Climate Change: A Detailed Bibliometric Investigation

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Abstract: This paper presents a detailed bibliometric analysis of the interaction between financial development and climate change, with the main aim of elucidating the current state of research in this area, identifying existing gaps, and guiding future researchers interested in this rapidly expanding field. The study used VOSviewer software version 1.6.18 to analyze the bibliometric data, facilitating the mapping of co-author networks, institutional collaborations, and the identification of main research directions. Through this tool, 730 papers from the Web of Science database covering the period 2010–2024 were extracted and analyzed. The study highlights the authors and institutions that have made significant contributions to the investigation of the relationship between financial development and climate change. The identification of key contributors and international collaborative networks provides a solid foundation for future research and policy initiatives. In addition, the study identifies the most prolific journals and assesses the quality and impact of the research. This allows for a deeper understanding of current research directions and potential future developments. The study not only clarifies the current state of research but also opens up new opportunities for investigating innovative and sustainable solutions aimed at improving the quality of life and protecting the environment.

Keywords: financial development; climate change; bibliometric analysis; VOSviewer; Web of Science

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1. Introduction

In recent decades, the relationship between financial development and climate change has become a major topic of interest for researchers and policymakers. This relationship is particularly relevant in the context of emerging economies' growth and the intensification of climate change effects (Abbasi and Riaz 2016). While financial development is often considered a driver of economic growth, its impact on the environment remains complex and often contradictory, ranging from supporting investments in green technologies to increasing energy consumption and carbon emissions (Li et al. 2021).

Existing studies have provided varied perspectives on this relationship. For instance, Tamazian et al. (2009), analyzing BRICS economies, concluded that financial development can contribute to reducing environmental degradation. Similarly, Tamazian and Rao (2010) demonstrated that financial liberalization could lead to a decrease in CO_2 emissions in 24 transition economies, thereby improving environmental quality. These findings have been confirmed in other geographical contexts: Jalil and Feridun (2011) for China, Shahbaz et al. (2013) for Malaysia and South Africa, and Dogan and Seker (2016) for countries ranked high on the renewable energy attractiveness index, all of which highlighted similar positive effects.

On the other hand, there are studies that emphasize the negative consequences of financial development on the environment. For example, Zhang (2011) reported a neg-

ative relationship between financial development and the environment in China, while Charfeddine and Khediri (2016) identified similar effects in Indonesia, and Javid and Sharif (2016) showed that financial development had unfavorable environmental consequences in Pakistan.

At the same time, some studies have not identified any significant relationship between financial development and environmental degradation. Cetin and Ecevit (2017) found no clear evidence of such a relationship in Turkey, Omri et al. (2015) reported mixed results for MENA countries, and Bekhet et al. (2017), similar to Çoban and Topcu (2013), obtained neutral results for European Union countries. These divergent findings highlight the complexity of the relationship between financial development and environmental degradation, underscoring the need for further studies to explore this interaction in depth.

Despite the extensive research on the relationship between financial development and climate change, there remain several significant gaps in the literature. First, while many studies have investigated this relationship in specific geographical contexts or economic sectors, there is a lack of a unified, large-scale bibliometric analysis that systematically synthesizes the available research across different regions and disciplines. This gap is particularly important as it limits the understanding of how financial development affects environmental outcomes on a global scale. Second, existing literature often treats the topic in a fragmented manner, without considering the broader networks of collaboration between authors and institutions that have shaped this research. By addressing this gap, our study provides valuable insights into the main contributors, their networks, and how their collaborations influence the development of knowledge in this field. Finally, there has been limited exploration of emerging research trends and the identification of underexplored areas that could benefit from further investigation. Our study aims to fill these gaps by offering a comprehensive bibliometric analysis that not only maps the current landscape but also reveals areas where future research can be directed.

Thus, while numerous studies have explored the relationship between financial development and environmental outcomes in specific contexts, this study offers a unique contribution by adopting a comprehensive bibliometric approach. Unlike prior research, which predominantly focuses on empirical analyses within certain geographical regions or economic sectors, our study systematically synthesizes the broader academic landscape. By conducting an in-depth bibliometric analysis, we provide a unified overview of global research trends, key contributors, and institutional collaborations in the field. This allows us to not only highlight the most influential works but also to identify critical research gaps and emerging trends that have yet to be extensively explored. As such, this study fills a significant void in the literature by offering a large-scale, data-driven analysis of the intersection between financial development and climate change, thus setting a foundation for future empirical and theoretical work in this area.

The novelty of this article lies in its systematic and comprehensive approach to a complex issue that has often been treated fragmentarily in the literature. To date, research on the impact of financial development on the environment has been predominantly conducted through empirical studies in specific geographical or economic contexts. However, a bibliometric analysis that synthesizes and unifies these studies has not been extensively conducted, making this study the first comprehensive systematic quantitative analysis of research on financial development and climate change. Through a detailed bibliometric analysis, this research aims to provide a synthesis of research trends, identify the most influential authors and institutions, and explore the collaboration networks among researchers. Additionally, we will map the main journals publishing work in this field and analyze emerging research trends. To this end, we propose a series of research questions that will be addressed throughout this paper:

RQ1: What is the trajectory of the evolution of scientific articles published to date?

RQ2: Who are the most cited authors in the study of the relationship between financial development and climate change?

RQ3: Who are the most prolific authors on this topic?

RQ4: What are the main institutions that have investigated and published on this subject?
RQ5: Which journals publish the most articles on the investigated relationship?

Thus, the main objective of this study is to provide a comprehensive overview of the current academic landscape regarding the relationship between financial development and climate change and to identify future research directions that can contribute to a better understanding and addressing of the global challenges associated with these two interconnected fields. In a global context marked by the increasingly pressing challenges posed by climate change and the urgent need to find sustainable solutions, this study aims to highlight how the financial sector can influence the environment both positively and negatively.

This article makes a significant contribution not only by identifying research trends and key authors in the field but also by exploring the existing gaps in the literature, thereby providing a clear framework for future research. By identifying and thoroughly analyzing these gaps, the article paves the way for further, more in-depth, and well-targeted investigations, thus contributing to a better understanding of the interactions between financial development and climate change. Essentially, our study not only adds academic value but also provides a solid foundation for formulating policies and strategies that optimize the impact of financial development on the environment in a sustainable manner.

To achieve the proposed objectives, this paper is structured as follows: Section 2 is dedicated to the methodology, where the research design, data collection methods, and analysis techniques are presented. Section 3 presents the results, which are divided into several subsections: Section 3.1 Description of Literature Data, providing an overview of scientific output on the topic of financial development and climate change and the types of documents published to date; Section 3.2 Top Authors, highlighting the most cited authors and author activity; Section 3.3 Analysis of Institutional Co-Authorship, examining collaborations between institutions; and Section 3.4 Analysis of Specialized Journals, reviewing relevant academic journals. Finally, Section 4, Conclusions, summarizes the main findings, discusses their implications, and offers recommendations based on the research.

2. Methodology

Bibliometric analysis is a quantitative method applied to bibliographic data to highlight the core theoretical and empirical research within a specific domain (Chen et al. 2014; Ellili 2024). This approach is widely recognized in the literature for its ability to uncover the development trajectory of a particular field and to examine its intellectual structure (Donthu et al. 2021; Verma and Gustafsson 2020). Bibliometric analysis typically utilizes databases containing information on published research in the area of interest. One such widely used database is the Web of Science (WOS), which hosts a vast collection of research outputs. In this study, we utilized WOS and employed the keywords "financial development" and "climate change", applying the "must include" condition to ensure relevance. This yielded a dataset of 730 works published between 2010 and 2024. The format of the WOS database enables its use for bibliometric analysis by allowing exportation of the data into specialized software, such as the VOSviewer tool. This software facilitates the extraction, mapping, and clustering of data from bibliographic fields (e.g., titles, authors, keywords, journals, and affiliations) (Van Eck and Waltman 2017; Orduña-Malea and Costas 2021; Xie et al. 2020). VOSviewer generates three types of visualizations: network, overlay, and density. In network visualization, each keyword, author, or country/organization is represented as a node, with the size of the node corresponding to the number of publications associated with that entity (Kuzior and Sira 2022). Co-author network analysis highlights the number of publications co-authored by at least two countries/regions, institutions, or authors, while co-occurrence analysis of keywords shows how frequently two terms appear together in the selected publications (Kamdem et al. 2019).

To provide a clear understanding of the methodology applied in this research, we present a flowchart outlining the key stages of the analysis (see Figure 1). This workflow

systematically demonstrates the steps taken to ensure a rigorous and comprehensive examination of the dataset.

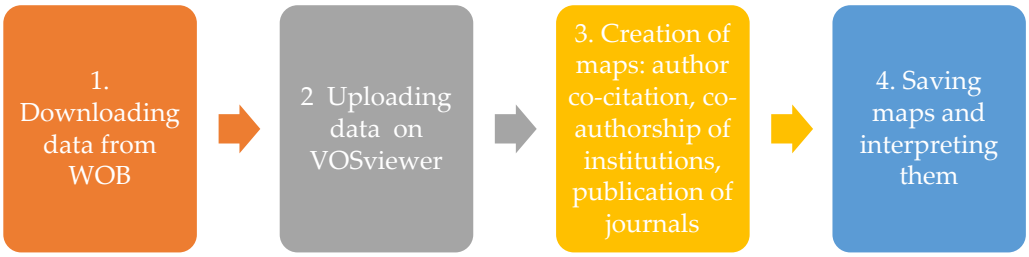

Figure 1. Steps of bibliometric analysis. Source: own processing.

In this bibliometric analysis, we employed several key analytical methods. First, citation mapping was used to identify the most influential authors in the field, addressing Research Question 2 (RQ2): Who are the most cited authors? Through this method, we were able to identify the studies that have significantly shaped the discourse on financial development and climate change, offering valuable insights into the academic landscape. Second, we utilized co-occurrence analysis, which provides a deeper understanding of the thematic focus within the literature. This approach reveals the frequency with which specific keywords appear together, making it particularly relevant for Research Question 1 (RQ1): What is the trajectory of the evolution of scientific articles published to date? Additionally, this method contributes to answering Research Question 5 (RQ5): Which journals publish the most articles on the investigated relationship? By examining keyword relationships, co-occurrence analysis helps in identifying emerging research trends and pinpointing gaps within the literature. In addition, we conducted co-author network analysis to map institutional collaborations within the field. This method enables the identification of the key institutions engaged in research on financial development and climate change, addressing Research Question 4 (RQ4): What are the main institutions that have investigated and published on this subject? By examining the collaboration patterns, we gain a clearer understanding of the intellectual networks contributing to this area of study. Finally, journal mapping was employed to analyze trends in specific journals, assisting in the response to Research Question 5 (RQ5) by determining which journals are most central to the discourse on financial development and climate change. This analysis offers a clearer perspective on the publication landscape within the field.

3. Results

This paper aims to examine the data from the specialized literature, identify the years with the highest research activity, highlight the authors who have investigated the relationship between financial development and climate change, analyze institutional collaborations among co-authors, and rank the most prolific countries in this field. Additionally, we will assess the quality and impact of the research, identifying the top journals that ensure visibility and recognition of scientific work within the academic community. To achieve these objectives and address the research questions, the analysis will be based on the information provided by the Web of Science, and the results of the bibliometric analysis will be structured into several sections.

3.1. Description of Literature Data

3.1.1. Scientific Output on the Topic of Financial Development and Climate Change

This section focuses on addressing RQ1 by analyzing the evolution of scientific articles published on the relationship between financial development and climate change over the selected time period (see Figure 2). It can be observed that in the first half of the first decade included in the analysis (2010–2015), research on this topic progressed slowly. However, academic attention has increased from 2016 onwards, reaching over 10 publications per year. In the past five years, there has been a significant rise in the number of published

articles, peaking at over 150 publications in 2022 and 2023. This trend reflects a growing interest from the academic community and an intensification of research in this field, driven by the increasing focus on sustainable and environmentally friendly development, as well as the publication of special issues.

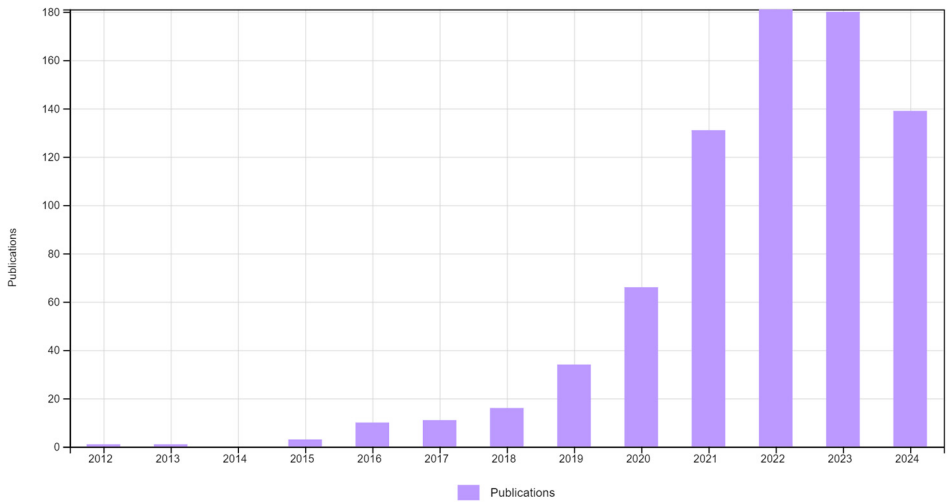

Figure 2. Evolution in the number of scientific articles. Source: Web of Science.

Regarding the number of citations (see Figure 3), it is evident that as the number of publications increases, so does the citation count, reflecting an intensifying concern for these domains. In 2022, the highest number of citations was recorded, exceeding 8000, indicating that publications from this period had a significant impact and were widely referenced. In the last two years covered by the analysis, although the number of citations slightly decreased in 2023 and more noticeably in 2024, it remains high compared to the period before 2018. This trend suggests increased academic recognition and growing relevance of research on the interaction between financial development and climate change.

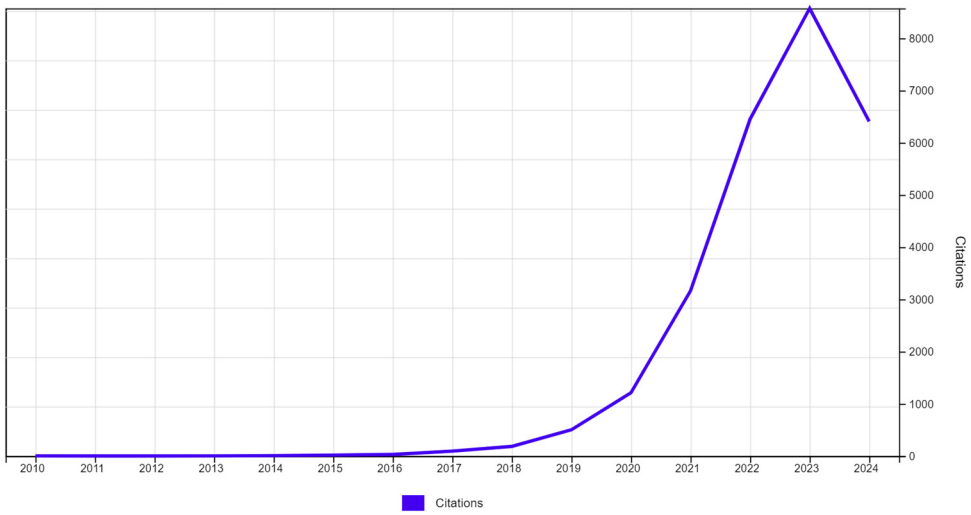

Figure 3. Evolution in the number of citations. Source: Web of Science.

Thus, this graph highlights a marked increase in interest and academic activity in researching the relationship between financial development and climate change, beginning in 2016. It emphasizes the growing importance of the topic in recent academic discussions and suggests a global recognition of the relevance of the relationship between financial development and climate change.

3.1.2. Document Types

The selected set of publications is diverse, encompassing a variety of formats and types of works in the field of financial development and climate change. However, according to Figure 4, the predominant category is scientific articles, representing 96.7% of the publications in this field (706). This suggests that the majority of research on this topic is presented in the form of original research articles. Another significant category is early access articles, totaling 57 works (7.8%), indicating an interest in the rapid publication of new and relevant research in the investigation of the relationship between financial development and climate change. Review articles (18) also represent an important part of the literature, aiming to synthesize and analyze existing studies, providing a comprehensive perspective on the current state of knowledge in this field. There are also other categories of publications, but these are much less represented. These include the following:

- Proceedings papers (5);
- Book chapters (2);
- Retracted publications (2);
- Book (1);
- Correction (1);
- Editorial material (1).

Figure 4. Typology of documents. Source: Web of Science.

The graph clearly shows that research in the field of the relationship between financial development and climate change is predominantly concentrated in scientific articles, with a lesser focus on early access and review articles. This reflects a varied approach, but with a strong emphasis on the rapid and detailed dissemination of research findings.

3.2. Top Author

The number of citations and publications is an indicator of the relevance and impact of the research conducted by authors. By analyzing the most cited authors, we can uncover collaboration networks and identify top institutions that contribute to this research. This information can be useful for establishing new academic or industrial collaborations and partnerships.

Thus, this section will highlight both the most cited authors and those with the highest number of publications in this field. This analysis helps us identify opinion leaders and recognized experts in the domain. An author with many citations and publications significantly contributes to the advancement of knowledge in this field and influences future research directions.

3.2.1. The Most Cited Authors

Bibliometric analysis using VOSviewer allows for the identification of the most cited authors in the field of interest, both through direct citations of the authors and through co-citations in various publications. The graphical representations generated by this type of analysis highlight the most influential authors in the field, providing valuable support for documentation. Figure 5 presents the co-citation map, where the unit of analysis is the authors, and by setting a minimum threshold of 20 citations per author, 470 authors were identified out of a total of 17,402. The larger the node (circle), the more cited the author. Additionally, thicker links between nodes indicate more frequent co-citation between authors.

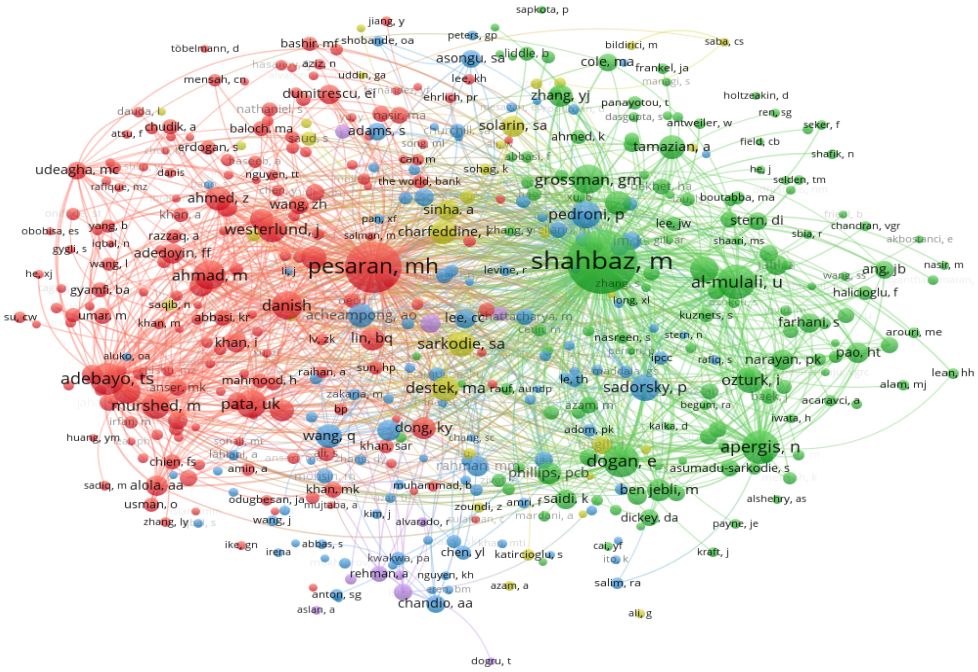

Figure 5. Co-citation of authors. Source: own.

These authors have been grouped into five distinct clusters, identified by the colors red, green, blue, yellow, and purple. The first cluster (red) includes 178 authors, with the most cited being Pesaran, M. (97 citations); Davis, F.D. (754 citations); Adebayo, T. (296 citations); and Ahmad, M. (246 citations). The second cluster (green) comprises 143 authors, with Shahbaz, M. (1162 citations) and Al-Mulali, U. (353 citations) being the most representative. The blue and yellow clusters have 106 and 33 authors, respectively, with the most influential being Pedroni, P. (226 citations) and Sadorsky, P. (210 citations) for the blue cluster, along with Destek, M. (184 citations) and Sarkodie, S. (181 citations) for the yellow cluster. The final cluster (purple) includes 10 authors, among whom Paramati, S. (98 citations) is the most cited, ranking among the top 30 cited authors in this field.

Therefore, this analysis addresses the research question RQ2: "Who are the most cited authors in the study of the relationship between financial development and climate change?" by identifying the authors with the greatest impact in this field based on the number of citations. The list of these authors includes names such as Shahbaz, M (1162 citations); Pesaran, M. (754 citations); Al-Mulali, U. (353 citations); Apergis, N. (320 citations); Dogan, E. (312 citations); Adebayo, T. (296 citations); Grossman, G. (250 citations); Ahmad, M. (246 citations); Danish (237 citations); Pata, U. (235 citations); Pedroni, P. (226 citations); and Sadorsky, P. (210 citations). The remaining authors have recorded fewer than 200 citations.

This identification not only acknowledges the significant contributions of these authors but also provides insight into the research networks and academic influence in the field of the relationship between financial development and climate change.

To highlight the most cited papers and identify whether they belong to the most cited authors, we conducted an additional analysis (Figure 6). The results show that the most cited papers do not necessarily belong to the authors with the highest citation counts. This suggests that top authors achieve their position not through the exceptional impact of a single paper but rather through high productivity and frequent collaborations with other researchers. By publishing a large number of papers, these authors consistently accumulate citations, which, when combined, place them at the top of the most cited authors in this field.

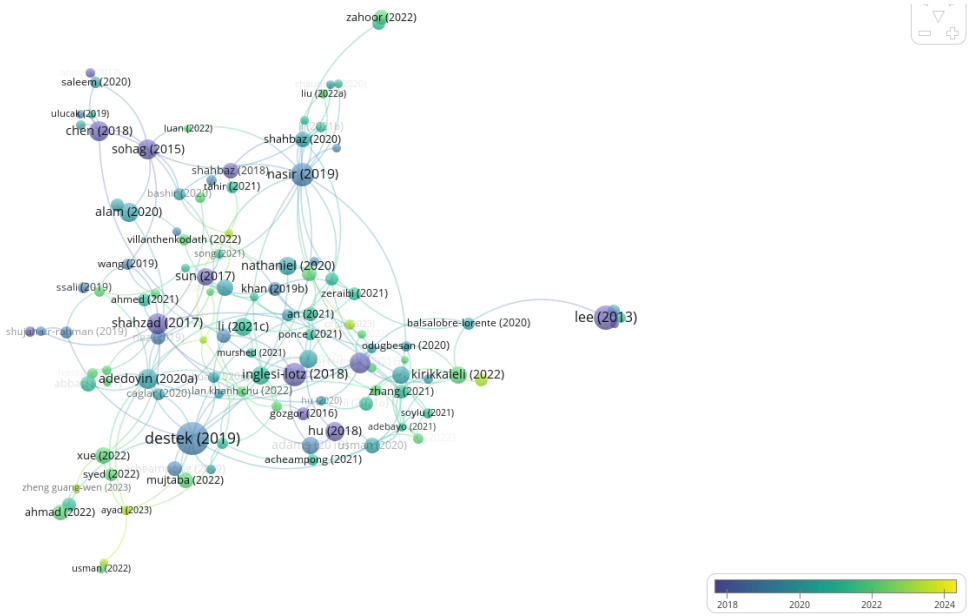

Figure 6. The most cited papers. Source: own.

According to Figure 6, the most cited paper is titled "Investigation of environmental Kuznets curve for ecological footprint: The role of energy and financial development", authored by Destek and Sarkodie (2019), which has accumulated 750 citations. This paper explores the environmental Kuznets curve and the impact of energy and financial development on the ecological footprint. The second place is occupied by a paper with 442 citations titled "Investigating the influence of tourism on economic growth and carbon emissions: Evidence from panel analysis of the European Union", authored by Lee and Brahmasrene (2013). It analyzes the influence of tourism on economic growth and carbon emissions in the European Union. In third place, with 406 citations, is the paper "The role of renewable energy consumption and commercial services trade in carbon dioxide reduction: Evidence from 25 developing countries", authored by Hu et al. (2018). This paper highlights the role of renewable energy and trade in reducing CO_2 emissions in developing countries. The paper titled "Role of financial development, economic growth & foreign direct investment in driving climate change: A case of emerging ASEAN", published by Nasir et al. (2019) ranks fourth with 389 citations, investigating the influence of financial development, economic growth, and foreign investments on climate change in ASEAN countries. In fifth place, with 320 citations, is the study "Carbon emission, energy consumption, trade openness and financial development in Pakistan: A revisit", authored by Shahzad et al. (2017), which reevaluates the relationship between carbon emissions, energy consumption, and trade openness in Pakistan. The paper "The impact of trade openness on global carbon dioxide emissions: Evidence from the top ten emitters among developing countries", authored by Ertugrul et al. (2016), ranks sixth with 304 citations. In seventh place, with 287 citations, is the paper "Dynamics of energy use, technological innovation, economic growth and trade openness in Malaysia", published by Sohag et al. (2015) which investigates the dynamics of energy consumption, technological innovation,

and economic growth in Malaysia. The eighth spot, with 282 citations, is held by the paper "Energy consumption, economic expansion, and CO_2 emission in the UK: The role of economic policy uncertainty", authored by Adedoyin and Zakari (2020). In ninth place, with 275 citations, is the paper "The impacts of economic growth, trade openness and technological progress on renewable energy use in organization for economic co-operation and development countries", authored by Alam and Murad (2020). Finally, in tenth place, with 273 citations, is the paper "Determinants of Carbon Emission in China: How Good is Green Investment?" authored by Li et al. (2021).

This analysis highlights the fact that the most cited papers are not necessarily authored by the most prolific researchers, demonstrating that academic impact is not solely dependent on a single successful study but also on the consistency and diversity of contributions over time. In conclusion, the most cited authors are often those who demonstrate the ability to tackle various topics and collaborate on multiple projects, which places them at the top of the academic hierarchy, even if not all of their works are individually considered seminal.

To better contextualize the cited studies and clarify how they inform the research questions posed, we highlight several key contributions from the most cited papers in the field. For example, the most cited paper by Destek and Sarkodie (2019), which examines the environmental Kuznets curve (EKC) and the role of energy and financial development in shaping the ecological footprint, offers significant insights into how financial systems influence environmental outcomes. This study is directly relevant to our first research question (RQ1) by demonstrating how financial development, through different mechanisms, can either exacerbate or mitigate environmental impacts. This aligns with our goal of tracing the evolution of research in this area and understanding the dual role of finance in environmental degradation and sustainability efforts.

Similarly, Lee and Brahmasrene's (2013) study, which investigates the influence of tourism on economic growth and carbon emissions in the European Union, broadens the scope of the discussion by introducing the sectoral impact of tourism. This study helps to inform both RQ1 and RQ2, as it illustrates how financial development, particularly within the tourism sector, interacts with economic and environmental dynamics. This highlights the diverse ways in which financial and economic activities influence carbon emissions, contributing to our understanding of the broader literature landscape.

Further supporting our research focus, the fourth most cited paper by Nasir et al. (2019) examines the relationship between financial development, foreign direct investment, and economic growth in driving climate change in ASEAN countries. This paper is directly linked to RQ3 and RQ4, as it identifies financial development and foreign investment as key factors influencing environmental policies in emerging markets. The study also provides insights into the role of institutions and regional actors in shaping the research landscape on financial development and climate change.

Additionally, Shahzad et al.'s (2017) work revisiting the link between trade openness, energy consumption, and carbon emissions in Pakistan highlights the importance of institutional and national contexts in addressing global environmental challenges. This paper contributes to our understanding of RQ4 and RQ5 by showcasing the institutional collaborations and journal outlets that have played a pivotal role in disseminating findings related to financial development and environmental impacts.

By incorporating these foundational studies, we offer a more nuanced view of the existing literature, directly linking key findings to our research questions. This strengthens the introduction and provides a clearer understanding of how previous research informs the trajectory of this field.

3.2.2. Activity per Author

Authors with a high number of publications are often thought leaders and recognized experts in their field, and identifying these authors helps recognize those who have substantially contributed to advancing knowledge and establishing new paradigms. Additionally, knowing the prolific authors can facilitate the formation of new academic collaborations

and research partnerships. Thus, this analysis will provide numerous advantages and address RQ3: "Who are the most prolific authors on this topic?"

For this analysis, VOSviewer and the WOS database were also utilized. To provide a clearer and more conclusive picture, a minimum threshold of 5 publications per author was set, identifying 34 authors from a total of 1994. Figure 7 illustrates the mapping of the most prolific authors across five clusters. According to the results, the authors with the most publications on the relationship between financial development and climate change are Adebayo, T and Shahbaz, M, each with 18 publications. They are followed by Bekun, F., who has 17 publications in the field, and Chandio, A., with 13 publications. Oztuk, I.; Kirikkaleli, D., and Murshed, M. are ranked 4th, each with 12 publications. The 5th position is held by Usman, M., with 10 publications, while the remaining authors have fewer than 9 publications.

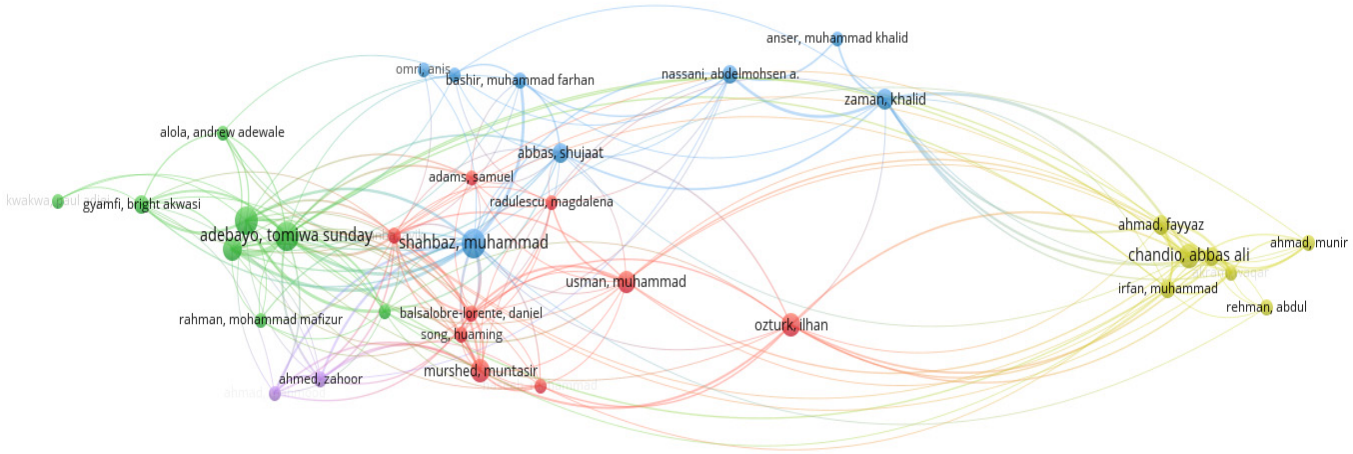

Figure 7. Mapping authors with publications in the field. Source: own processing.

If we were to create a graphical representation of the top 10 authors with the most publications in this field, it can be illustrated as shown in Figure 8:

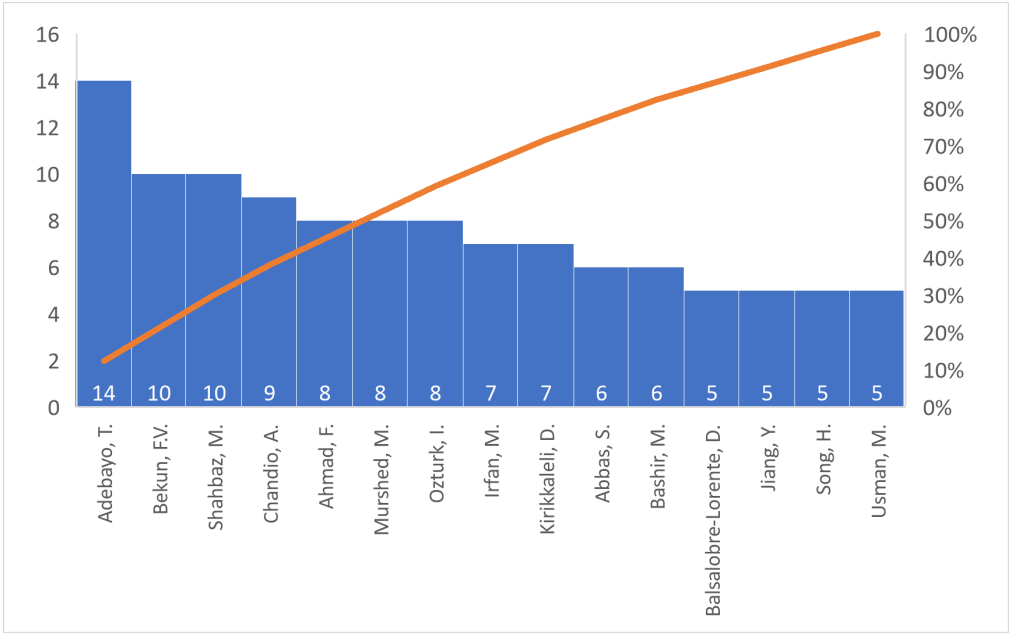

Figure 8. Ranking of the most prolific authors. Source: own processing.

When we relate the results from Section 3.2.1 with those from Section 3.2.2, we observe that authors with the highest number of publications are not necessarily the most cited. This can be explained by the fact that authors with many publications might publish in journals with lower impact, leading to a relatively lower number of citations. On the other hand, highly cited authors may publish less frequently but in top journals and on high-interest topics, thus attracting a large number of citations.

In conclusion, while the number of publications is an indicator of an author's productivity, the number of citations more directly reflects their impact and influence within the academic community. However, when combined, these factors provide a more comprehensive view of an author's contributions and academic recognition.

3.3. Analysis of Institutional Co-Authorship in the Field

This analysis aims to answer RQ4 (What are the main institutions that have investigated and published on this subject?) and highlight the key institutions that have researched and published articles on the topic of interest, as well as to illustrate the collaborations between them. From the total of 1112 institutions, applying a threshold of five published works to identify the most prominent institutions publishing studies on financial development and economic growth, a ranking of 85 institutions was obtained, divided into eight clusters. According to Figure 9, the most significant institutions regarding the number of published documents and collaborations with other institutions are shown.

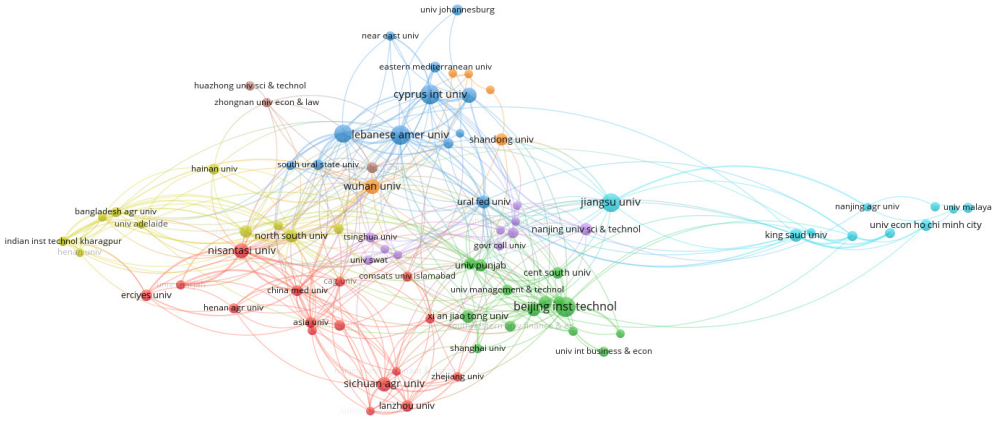

Figure 9. Institutions' co-authorship network. Source: own processing.

The top institution in this ranking is Beijing Institute of Technology, with 27 publications, representing 3.699% of the total works. Lines extending from this institution indicate intense collaboration with other institutions in this research field. This university has had the most collaborations with the University of International Business and Economics, Shanghai University, and Gulf University for Science and Technology. The next institution with a significant number of publications (26) on the relationship between financial development and climate change is Lebanese American University. This university has notable collaborations with institutions in Turkey, such as Istanbul Gelisim University and Istanbul Ticaret University, as well as institutions from other countries, including Cyprus International University, University Utara Malaysia, and Shenzhou University.

The third-ranked institution in terms of the number of publications in the field of interest is Cyprus International University with 25 publications (3.425%). Researchers from this university have collaborated with other researchers from Eastern Mediterranean University, European University of Lefke, and Lebanese American University. Jiangsu University ranks fourth in the list, with researchers from this institution having published 24 works (3.28%). Most collaborations were with other universities in China (Shandong University, Zhengzhou University, and Nanjing University of Information Science and Technology), but international collaborations were also observed, such as with the University of the Punjab, Prince Sattam bin Abdulaziz University, and others.

Another institution with a publication record of over 20 is Istanbul Gelisim University (21), which has diverse international cooperation, collaborating most frequently with institutions such as South Ural State University, Wuhan University, and Lebanese American University. Although the remaining institutions have published fewer than 20 works, their contributions should not be overlooked, including Istanbul Nisantasi University (16), Lefke Avrupa University (16), Wuhan University (16), Sichuan Agricultural University (14), China Medical University Taiwan (13), and COMSATS University Islamabad CUI (12), among others.

In conclusion, the analysis highlights that institutions from China and Turkey are leaders in publishing articles on the relationship between financial development and climate change, due to some key factors. These countries allocate significant funds for research and development, focusing on innovation and eco-friendly technologies. Both countries are committed to supporting the Sustainable Development Goals (SDGs), promoting investments in green solutions. Additionally, environmental challenges, such as pollution in China and Turkey's vulnerability to climate change, necessitate investments in adaptation and mitigation solutions. However, institutions from other countries have also contributed to clarifying this relationship (see Figure 10), emphasizing the significance of these countries in researching this field. Regarding international collaboration, top institutions are observed to collaborate extensively with universities from different countries. This diversity of international collaborations reflects a global research network that enhances and deepens knowledge in the fields of financial development and climate change. These transnational partnerships not only increase the visibility and impact of studies but also stimulate scientific innovation and progress through the exchange of ideas and resources among participating institutions.

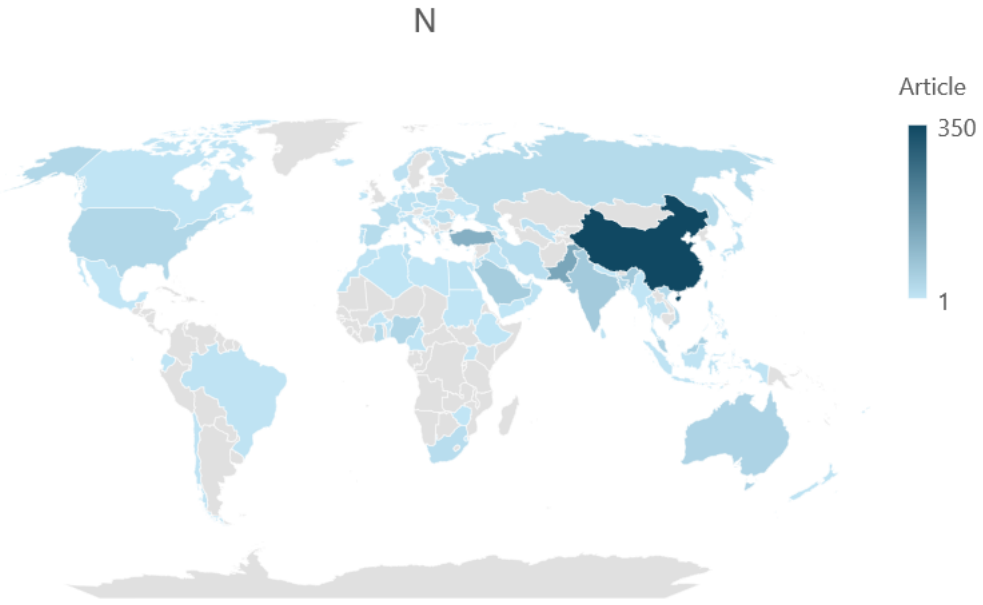

Figure 10. Prolific countries/regions. Source: own processing.

3.4. Analysis of Specialized Journals

In this section, we chose to analyze the journals in which research articles are published because this provides several advantages, including:

- Research quality assessment: top journals, with rigorous peer-review standards, indicate the quality and relevance of research.
- Determining visibility and impact: articles published in reputable journals are more likely to be cited and influence future research.
- Identifying research trends: journal analysis helps identify emerging trends and topics of major interest.

- Establishing field relevance: the frequency and distribution of articles in certain journals indicate the importance of a research field.
- Facilitating collaborations and partnerships: identifying top journals allows for the establishment of valuable academic collaborations.
- Access to quality publications: researchers can access the most relevant publications to stay up to date with the latest findings.

Consequently, this analysis will address the fifth research question: "Which journals publish the most articles on the investigated relationship?" A total of 730 papers were published in 172 scientific journals. Figure 11 illustrates the total number of journals, with the minimum threshold of articles published in a journal being one. The number of publications varies, and based on the map, we can rank the journals where articles on the relationship between financial development and climate change have been published.

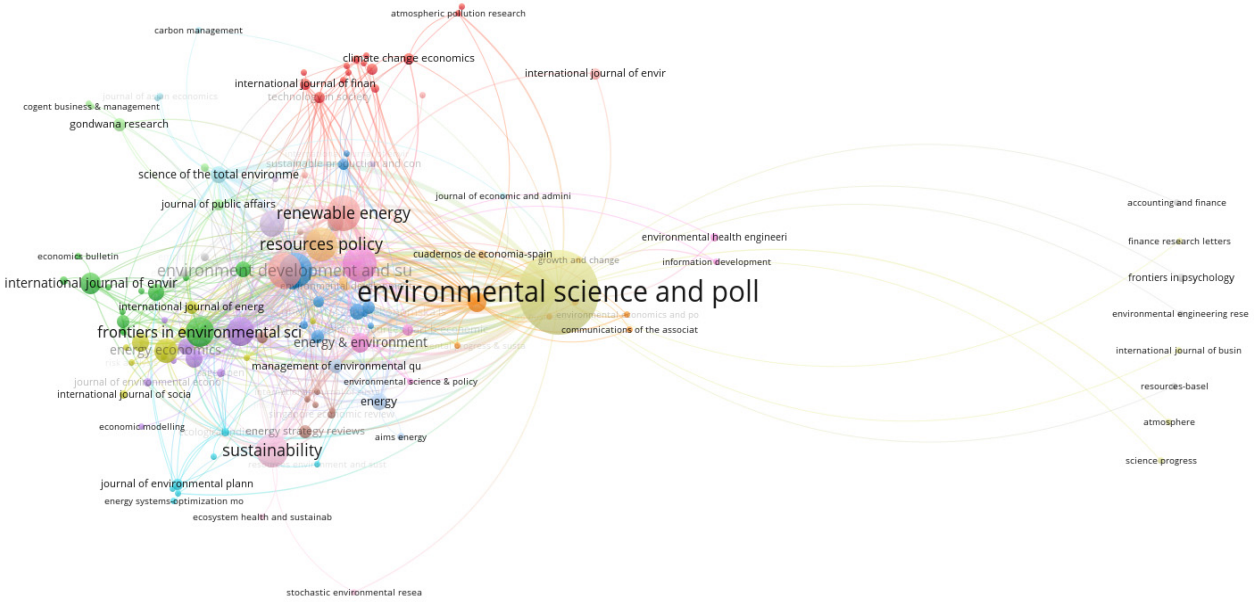

Figure 11. Mapping of specialized journals. Own processing.

Thus, the most articles (164) were published in the journal *Environmental Science and Pollution Research*, which had an impact factor of 5.8 in 2022. This is followed by three other journals, each publishing 30 articles on the topic over the years. The first among them is *Renewable Energy*, with an impact factor of 8.7 in 2022. The other two are *Journal of Cleaner Production*, with an impact factor of 11.1, and *Environment, Development and Sustainability*, with an impact factor of 5.6. Another journal with a significant number of papers is *Energies*, which had an impact factor of 3.2 in 2022 and published 29 articles. The journals *Sustainability* and *Resources Policy* each published 27 articles, with impact factors of 3.9 and 10.2, respectively. The journal rankings are followed by *Frontiers in Environmental Science* with 22 publications and an impact factor of 3.3 in 2022, and *Journal of Environmental Management* with an impact factor of 8.0 and 20 publications on this subject over time. Other journals (*Natural Resources Forum*, *Energy Economics*, *International Journal of Environment*, etc.) have published fewer than 20 articles.

If we analyze the ranking of these (see Table 1), we find a clear trend of publication in high-quality journals with a significant impact in the field of sustainable development and the environment, which we consider to be a validation of the quality of the research papers published on the analyzed topic in this study. This is considered a validation of the quality of the research work published on the topic analyzed in this study. Additionally, most articles are published in journals ranked in the first quartile (Q1), which are the most prestigious journals in the field.

Table 1. Analysis of the journals.

No.	Journal	H-Index	Impact Factor (2022)	Impact Factor over the Last 5 Years	Quartile	Number of Articles Published	Number of Citations
1	*Environmental Science and Pollution Research*	179	5.8	3.99	Q1	164	6375
2	*Renewable Energy*	250	8.7	6.99	Q1	30	2340
3	*Journal of Cleaner Production*	309	11.1	7.2525	Q1	30	1937
4	*Environment, Development and Sustainability*	82	5.6	4.7	Q1	30	360
5	*Energies*	137	3.2	3.0	Q1	29	472
6	*Sustainability*	169	3.3	3.6	Q2	27	440
7	*Resources Policy*	114	10.2	8.9	Q1	27	274
8	*Frontiers in Environmental Science*	77	3.3	5.2	Q1	22	160
9	*Journal of Environmental Management*	243	8.0	3.5	Q1	20	1734

Source: Own processing, using data provided by WOS.

Furthermore, the data analysis shows a clear correspondence between the number of published articles and the number of citations, with journals that publish more articles generally receiving more citations. For example, *Environmental Science and Pollution Research* has published 164 articles and recorded 6375 citations, while *Renewable Energy*, with 30 articles, has 2340 citations. This suggests that journals publishing more articles tend to have a greater impact, as reflected in the citation counts. However, there are minor exceptions, such as *Resources Policy*, which, despite publishing only 27 articles, has achieved 274 citations, indicating a disproportionately high influence relative to its publication volume.

In conclusion, the quality of the journals in which the articles are published is high, as reflected by their significant impact factors and h-index, demonstrating rigorous standards and relevance of the research in their respective fields.

4. Conclusions

This study provides a detailed analysis of the literature concerning the relationship between financial development and climate change, highlighting current research trends, identifying key authors and institutions, and evaluating the impact and quality of published research. The results demonstrate a significant increase in academic interest in this subject, with a growing number of publications in top-tier journals ranked in the first quartile (Q1), indicating a validation of research quality (Trinh et al. 2024; Appiah-Otoo et al. 2024; Liu et al. 2024; Pata et al. 2023; Ding et al. 2023). Additionally, we observed a strong correlation between the number of published articles and the number of citations, emphasizing the importance of visibility and influence of scientific work in this field. On the other hand, the analysis highlights that the most cited works do not always result from the most prolific researchers. This finding suggests that researchers who diversify their research topics and consistently collaborate with others can have a more significant impact in the academic community, thereby strengthening the relevance and influence of their work.

Specifically, this research makes significant contributions both theoretically and practically. On the theoretical side, this work greatly contributes to the literature by identifying and analyzing research trends concerning the relationship between financial development and climate change. We have highlighted the increasing importance of this topic in aca-

demic discussions, underscoring the global relevance of the relationship between these two areas. Our analysis also enabled the identification of authors and institutions with the most contributions in this field, providing a solid basis for recognizing opinion leaders and top institutions. This recognition helps establish a reference framework for future studies and academic collaborations. Lastly, another theoretical contribution is the emphasis on top journals where relevant articles are published, demonstrating that publishing in high-quality journals is essential for enhancing the visibility and impact of research.

From a practical standpoint, identifying top institutions and authors can guide international collaborations and resource allocation to relevant projects. The study highlights the importance of international collaborations and research networks, providing a framework for strengthening these networks. Institutions and researchers can use this information to identify new cooperation opportunities and maximize the collective impact of their research. Additionally, researchers can leverage the study's findings to optimize their publishing strategies by selecting journals with the highest impact for disseminating their results, thereby increasing the visibility and influence of their research within the academic community and beyond.

Although this study provides valuable insights, there are several limitations worth mentioning. First, the analysis relied exclusively on data from the Web of Science, which may restrict the diversity of sources and, consequently, the results obtained. Future research could benefit from integrating data from additional databases, such as Scopus or Google Scholar, to broaden the scope of the analysis. Second, the focus on bibliometric analysis, while providing useful quantitative information, does not always capture the qualitative aspects of the impact and significance of the research. It is essential for future studies to complement quantitative data with qualitative assessments to provide a more holistic understanding of the field.

Additionally, the analysis may have temporal constraints related to the period considered for publication trends and citation analysis. Extending this period could reveal changes in the focus and relevance of research over time.

Nevertheless, the study paves the way for several future research directions. One essential direction would be to incorporate a broader range of methodologies, including case studies and qualitative analyses, to enrich the understanding of the complex relationships between financial development and climate change. Case studies could provide concrete examples of interactions between these two fields, allowing for a detailed examination of how financial policies influence environmental initiatives in different geographical and economic contexts. These analyses could highlight best practices and successful strategies that can be replicated in other regions or countries, thereby offering a useful framework for formulating sustainable policies.

On the other hand, qualitative analyses, including interviews with experts, can bring to light the perspectives and opinions of those involved in the decision-making process, contributing to a deeper understanding of the factors influencing financial development and climate change. These approaches can help identify obstacles and challenges faced by institutions in implementing ecological and financial initiatives, as well as uncover emerging opportunities that could lead to innovative solutions.

Additionally, integrating mixed methods, which combine quantitative and qualitative data, can provide a more comprehensive picture of the impact of financial development on the environment. This approach could involve statistical analysis of financial and environmental data, coupled with interviews or surveys to understand the social and economic context in which these relationships manifest.

Thus, by diversifying research methodologies, future studies will be able to capture the nuances of the relationships between financial development and climate change, contributing to a more robust and applicable knowledge base for effective and sustainable policy formulation.

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