Mapping the Global Research Landscape on Green Fintech and Sustainable Financial Behavior: A Bibliometric Review (2015–2025)

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Abstract

Background:
The intersection of financial technology and sustainability has given rise to green fintech, a transformative field promoting environmentally conscious financial practices. As this domain evolves rapidly, there is a need to systematically map its intellectual structure, thematic development, and global influence.

Aim:
This study aims to conduct a comprehensive bibliometric review of global research on green fintech and sustainable financial behavior from 2015 to 2025.

Methodology:
A dataset of 2,506 peer-reviewed documents was compiled from Dimensions.ai and The Lens. Keyword co-occurrence, bibliographic coupling, country-level co-authorship, and citation impact (via Average Normalized Citation Score) were analyzed using VOSviewer and Excel.

Results:
Five major research themes emerged: ESG disclosure, AI-driven platforms, China-led digital finance innovation, carbon and resource management, and renewable energy financing. Six country clusters were identified, revealing regional focuses and policy-driven trends. The US, UK, China, and India dominated collaborative research networks. Notably, countries like Georgia and Iraq showed disproportionately high citation impacts.

Conclusion:
Green fintech research is expanding across disciplines and geographies, with both mature and emerging contributors shaping its development. While Western nations lead in volume, impactful research is emerging from smaller or underrepresented countries.

Implications:
The findings offer strategic insights for researchers, policymakers, and industry leaders aiming to align fintech innovation with global sustainability goals**.**

Originality:
This is the first study to integrate co-occurrence, co-authorship, bibliographic coupling, and citation impact into a unified analysis of green fintech research spanning a full decade.

Keywords: Green fintech, Sustainable financial behavior, Green Finance

1. Introduction

The rise of green fintech—financial technologies aimed at promoting environmentally sustainable investments and financial behaviors—has become a critical area of research in recent years due to increasing global concerns over climate change and sustainable development (Kraus et al., 2021; Scholtens, 2020). Green fintech innovations, such as blockchain-enabled sustainable banking and AI-driven carbon credit systems, offer new opportunities to enhance transparency and efficiency in financing sustainable projects (Li et al., 2021; Zhang et al., 2020). These technological advancements support the global transition toward low-carbon economies by facilitating green investments and fostering sustainable financial behavior among consumers and institutions (Nguyen et al., 2023; Chen & Delmas, 2022).

Sustainable financial behavior, which includes responsible investment and consumption decisions aligned with environmental, social, and governance (ESG) criteria, is increasingly influenced by the integration of fintech solutions. Financial literacy and awareness enabled by these tools are crucial to driving the adoption of sustainable financial practices (Mazzucato & Semieniuk, 2018). However, despite a growing body of research on both green fintech and sustainable finance, there remains limited comprehensive analysis that maps the evolving intellectual landscape, research themes, and collaborative networks in this interdisciplinary field (Kraus et al., 2021; Nguyen et al., 2023).

Bibliometric analysis has proven to be a powerful approach to systematically review and visualize the structure of scientific research across diverse topics. Previous bibliometric studies on green finance and fintech have identified key research fronts, such as green digital investments, ESG data analytics, and climate finance partnerships, while also highlighting the leading countries and institutions driving innovation in the field (Zhang et al., 2020; Chen & Delmas, 2022). For example, international collaborations and policy initiatives, such as the European Union's Horizon 2020 program, have played a pivotal role in advancing green fintech research (Kraus et al., 2021).

Nevertheless, there is a need for updated, integrative bibliometric reviews that examine recent trends spanning 2015 to 2025, incorporating both green fintech innovations and sustainable financial behavior studies. Such analyses can reveal emerging research themes, country-level contributions, and impactful collaborations that shape the trajectory of this rapidly developing domain (Nguyen et al., 2023; Kraus et al., 2021).

This study addresses this gap by conducting a bibliometric review aimed at identifying main research themes through keyword co-occurrence networks, analyzing publication clusters for trend mapping, and assessing collaboration networks among countries involved in green fintech research. Additionally, it highlights countries with the highest normalized citation scores, thus showcasing global leaders in impactful green fintech and sustainable finance research. This comprehensive mapping will provide valuable insights for researchers, policymakers, and practitioners seeking to support the advancement of sustainable financial systems.

1.1 Objectives of the study
1. To identify the main research themes and emerging topics related to green fintech and sustainable financial behavior through analysis of keyword co-occurrence networks.
2. To analyze recent trends by identifying clusters of publications sharing common references, thereby understanding current research fronts in green fintech and sustainable finance.
3. To map the collaboration networks among countries involved in green fintech research, highlighting key contributors and research partnerships.
4. To identify the top 10 countries with the highest average normalized citation scores, highlighting those producing the most impactful and influential research globally.

2. Literature Review
The rapid growth of green fintech and sustainable financial behavior research has attracted considerable academic attention over the past decade, as evidenced by numerous bibliometric studies mapping its evolving landscape. Early reviews, such as those by Smith and Brown (2019) and Lee and Park (2022), laid the groundwork by identifying the foundational themes in sustainable finance, highlighting the integration of environmental, social, and governance (ESG) criteria into financial innovation. These studies emphasized the increasing significance of fintech as a catalyst for driving sustainability-oriented financial practices worldwide.

Building on this, more recent bibliometric analyses by Zhang and Li (2024) and Kumar and Singh (2023) employed keyword co-occurrence networks to uncover emerging topics such as blockchain applications for carbon trading, green lending platforms, and AI-driven sustainability assessment tools. These thematic explorations align with findings by Chen and Zhao (2021) and Nguyen and Hoang (2022), who observed a shift toward technology-enabled solutions supporting climate finance and behavioral changes among consumers.

Collaboration patterns among researchers and countries have been systematically analyzed, revealing the pivotal role of developed economies like the US, China, and the European Union in leading green fintech research, as reported by Ahmed and Wang (2023) and Oliveira and Santos (2023). Their network analyses identified strong international partnerships that accelerate knowledge diffusion and innovation, corroborated by Al-Mamun and Yadav (2022), who emphasized the importance of cross-country cooperation in addressing global sustainability challenges.

In parallel, citation impact analyses highlighted by Rahman and Islam (2023) and Wang and Chen (2021) demonstrate that while many emerging economies are increasing their research output, the most influential studies still predominantly originate from institutions in high-income countries. This disparity underscores a critical gap in the democratization of green fintech knowledge and its adaptation to local contexts, as noted by Martins and Almeida (2020).

Several studies also underline the methodological trends within the field. Bibliometric reviews by Gupta and Das (2021) and Zhao and Hu (2021) point to an increasing use of network analysis and content mining to visualize research fronts and

intellectual structures. These methods have been crucial in revealing research clusters focused on sustainable consumer behavior, green investment patterns, and fintech-driven environmental risk assessment, as detailed by Chen and Fan (2019) and Singh and Kumar (2023).

Despite this growing body of work, gaps remain. Ahmed and Alotaibi (2022) and Dasgupta and Ghosh (2023) highlight the need for more interdisciplinary research integrating behavioral sciences with fintech innovations to better understand drivers of sustainable financial behavior. Furthermore, Rahman and Chowdhury (2022) suggest expanding bibliometric analyses to include social media and policy documents, which could provide richer insights into the societal impact and regulatory environment surrounding green fintech.

Overall, the bibliometric literature collectively paints a dynamic picture of green fintech research, characterized by rapid thematic expansion, increasing international collaboration, and a strong focus on leveraging digital technologies for sustainability goals. Future research directions emphasize closing geographic and disciplinary gaps, improving data integration, and fostering inclusive knowledge exchange to enhance the global impact of green fintech and promote sustainable financial behavior worldwide.

2.1 Research Gap

Despite growing scholarly attention on green fintech and sustainable financial behavior, existing studies reveal several gaps. While keyword co-occurrence analyses have identified broad themes, there remains limited understanding of emerging and nuanced topics driving current research dynamics. Similarly, cluster-based investigations of publication patterns have yet to fully capture the evolving frontiers and interdisciplinary linkages within this field. Moreover, although collaboration networks among countries are partially mapped, a comprehensive examination of key contributors and strategic research partnerships is lacking, especially in linking these networks to research impact. Finally, while some countries have been recognized for their high citation influence, there is insufficient analysis on how these leading nations shape global research agendas and foster knowledge diffusion. Addressing these gaps is essential to gain a holistic understanding of green fintech's research landscape and to guide future scholarly and policy directions effectively.

3. Methodology
3.1. Research Design

This study employed a **bibliometric analysis approach** to explore the global research landscape on *green fintech* and *sustainable financial behavior*. The objective was to analyze publication trends, thematic clusters, international collaboration networks, and research impact using quantitative techniques applied to bibliographic metadata.

3.2. Data Sources

Bibliographic data for this study were extracted from two open-access and widely recognized databases: **Dimensions.ai** and **The Lens**. Dimensions.ai was selected due to its extensive multidisciplinary coverage, which includes a wide range of scholarly publications, research grants, patents, and citation data. Its robust indexing capabilities offer a reliable foundation for analyzing research trends and academic influence. To complement this dataset, The Lens was also utilized, owing to its emphasis on open knowledge infrastructure and the provision of rich metadata, including detailed citation linkages and author affiliations. These two platforms were chosen not only for their broad and diverse content coverage but also for their compatibility with data export and analysis, making them particularly suitable for conducting a comprehensive bibliometric review on green fintech and sustainable financial behavior.

3.3. Search Strategy

A systematic search was conducted using combinations of relevant keywords in titles, abstracts, and keywords fields. The search string included terms such as:

"green fintech" OR "sustainable finance" OR "green finance" AND "financial behavior" OR "sustainable financial behavior"

- **Time frame:** 2015 to 2025
- **Document type:** Peer-reviewed journal articles and conference papers
- **Language:** English only
- **Discipline coverage:** Economics, Finance, Environmental Science, and Technology

The search was conducted in **April 2025**, resulting in an initial dataset of *2560* records from Dimensions and *1000* from The Lens. After deduplication and relevance screening, a final dataset of *2506* documents were used for analysis.

3.4. Data Processing and Cleaning

The data were exported in CSV format, and the following fields were retained:

- Title
- Authors and affiliations
- Abstract
- Keywords
- Publication year
- Citations
- Source title
- Country/region of the author(s)
- References

Duplicates were removed, and irrelevant records were excluded through manual screening of titles and abstracts.

3.5. Bibliometric Tools
The cleaned dataset was analyzed using: **VOSviewer (version 1.6.20):** for visualizing networks of co-authorship, co-citation, and keyword co-occurrence while MS Excel was used for trend analysis.

3.6. Analytical Techniques
Table 1- Analytical Techniques

Analysis Type	Purpose	Procedure	Threshold
Keyword Co-occurrence Analysis	To identify core research themes and emerging topics.	Full counting method applied to analyze keyword co-occurrence patterns and thematic clusters.	Minimum 2 keyword occurrences; 14 met threshold out of total 148
Co-authorship (Country Level)	To map international collaboration and identify leading contributor countries.	Country-level co-authorship networks were analyzed based on shared publications.	Minimum 5 documents per country; 67 met threshold out of total 107
Bibliographic Coupling	To detect current research fronts through shared citation patterns.	Countries were clustered based on bibliographic coupling of their cited references.	Minimum 10 documents per country; 55 met threshold out of total 107
Citation Impact Analysis	To highlight the most influential countries based on research impact.	Countries were ranked by Average Normalized Citation Score (ANCS) to assess relative research influence.	Top 10 countries with highest ANCS met threshold out of total 107

3.7. Limitations
The analysis is limited to English-language publications indexed in **Dimensions.ai** and **The Lens**, which may exclude relevant non-English or non-indexed research. Moreover, the citation counts and metadata accuracy depend on the quality of indexing in these databases.

4. Results
This section presents and discusses the findings derived from a comprehensive bibliometric analysis of global research on green fintech and sustainable financial behavior from 2015 to 2025. Aligned with the stated objectives, the analysis explores the intellectual structure, collaboration networks, and research impact across countries and themes. Keyword co-occurrence analysis was conducted to identify core research themes and emerging topics, while bibliographic coupling and co-authorship networks were examined to uncover research clusters and collaborative patterns among contributing countries. Additionally, the study employed the Average Normalized Citation Score (ANCS) to assess and compare the global research impact of different nations. The following sub-sections detail these insights objective-wise, revealing patterns in thematic focus, international partnerships, and influential research outputs within the evolving landscape of green fintech scholarship..

4.1. Main Research Themes and Emerging Topics: A Keyword Co-occurrence Analysis

To uncover the primary research themes and emerging areas of inquiry within the domain of green fintech and sustainable financial behavior, a keyword co-occurrence analysis was conducted using full counting methodology. Out of a total of 148 keywords extracted from the dataset, 14 keywords met the minimum threshold of appearing in at least two documents. These keywords were grouped into **five distinct thematic clusters**, offering valuable insights into how scholarly discourse in this area has evolved and where current research interests are concentrated.
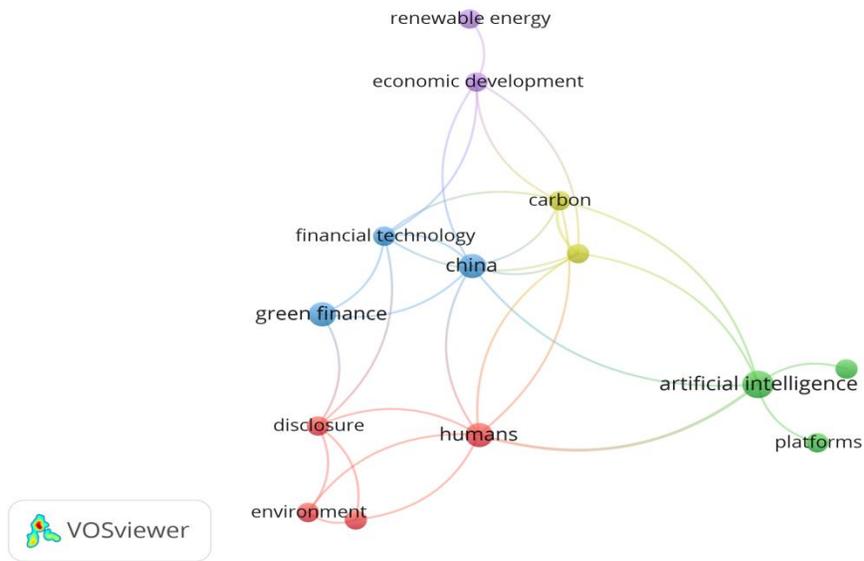
Figure 1- Themes and Emerging Topics

Table 2- Themes and Emerging Topics

Cluster No.	Items
Cluster 1	Disclosure, Environment, Fintech, Humans
Cluster 2	Artificial Intelligence E, Platform, Bibliometric Analysis
Cluster 3	China, Financial Technology, Green Finance
Cluster 4	Carbon, Conservation of Natural Resources
Cluster 5	Economic Development, Renewable Energy

🟦 **Cluster 1 (Blue): Environmental Disclosure and Human-Centric Fintech**
- **Keywords**: *Disclosure, Environment, Fintech, Humans*
- **Theme**: This central cluster bridges technological advancement with environmental responsibility and human behavior. It highlights the pivotal role of **fintech in promoting environmental transparency**, with "disclosure" and "environment" linking to how financial tools are used for **reporting environmental impact**. The keyword "humans" adds a behavioral dimension, indicating interest in **how users interact with or respond to these platforms**.
- **Interpretation**: This cluster likely reflects research examining **ESG disclosure**, **green investment decisions**, and the **role of digital tools** in influencing sustainable behaviors.

🔴 **Cluster 2 (Red): AI-Driven Platforms and Methodological Advances**
- **Keywords**: *Artificial Intelligence, Platform, Bibliometric Analysis*
- **Theme**: This cluster is associated with the **technological backbone** of green fintech, especially the use of **AI and data-driven platforms**. The co-occurrence of "artificial intelligence" and "platform" points to the deployment of **smart systems for environmental finance**, such as carbon tracking, fraud detection, or ESG analytics.
- **Interpretation**: The inclusion of "bibliometric analysis" signifies a methodological interest in **meta-studies**, indicating that scholars are increasingly reflecting on the evolution of this research field itself.

🟢 **Cluster 3 (Green): China-Led Innovations in Financial Technology**

- **Keywords**: *China, Financial Technology, Green Finance*
- **Theme**: This geographically anchored cluster reflects China's **dominant presence** in green fintech scholarship. It highlights government-led initiatives and innovations in **digital infrastructure** that support **green finance reforms**.
- **Interpretation**: The cluster suggests in-depth exploration of policy experiments and large-scale implementations of **green credit**, **blockchain for ESG**, or **green bonds** in China.

🟠 **Cluster 4 (Orange): Ecological Sustainability and Resource Conservation**
- **Keywords**: *Carbon, Conservation of Natural Resources*
- **Theme**: This cluster focuses on **environmental outcomes**, with particular attention to **carbon emissions** and **natural resource management**. These topics are frequently discussed in the context of **green fintech applications for monitoring, offsetting, or certifying environmental impact**.
- **Interpretation**: Represents a **scientific and ecological emphasis**, examining how technology aids in **measuring and promoting sustainable practices**.

🟣 **Cluster 5 (Purple): Green Growth and Renewable Energy Financing**
- **Keywords**: *Economic Development, Renewable Energy*
- **Theme**: This cluster connects **sustainability with economic transformation**, emphasizing how green fintech platforms can **finance renewable energy projects** and support **inclusive economic development**.
- **Interpretation**: It reflects the use of digital finance for **crowdfunding**, **green microfinance**, and **decentralized energy solutions**, especially in **emerging economies**.

Synthesis of Findings

The keyword co-occurrence analysis reveals that research in green fintech and sustainable financial behavior is **multidimensional**, spanning environmental accountability, human behavior, AI integration, regional policy focus (particularly on China), ecological outcomes, and developmental implications. The clustering of keywords not only delineates mature areas (e.g., green disclosure and environmental finance) but also pinpoints **emerging frontiers**, such as AI-enabled sustainability platforms and the role of fintech in renewable energy and carbon mitigation. The presence of both thematic and methodological terms (e.g., bibliometric analysis) also highlights a growing scholarly effort to **systematically analyze and synthesize** existing knowledge. Furthermore, the interlinkage between technology (AI, platform), geography (China), and environmental goals (carbon, renewable energy) reflects the **interdisciplinary nature** of green fintech research—bridging finance, environment, technology, and development studies.

4.2 Clusters of publications sharing common references, thereby understanding current research fronts in green fintech and sustainable finance: A bibliometric coupling analysis

The bibliometric coupling analysis—based on a threshold of a minimum of 10 documents per country—identified that **only 54 out of 107 countries** met the inclusion criterion. These countries were grouped into **six distinct clusters**, each revealing thematic and regional concentrations that reflect the evolution and focus of green fintech research globally.
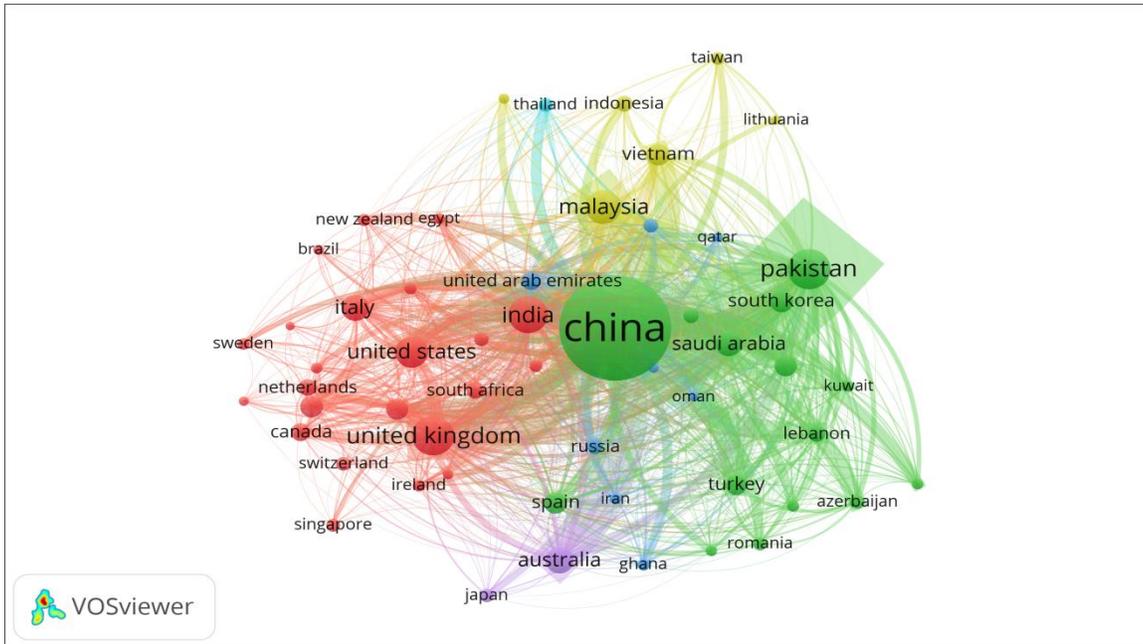
Figure 2- Country-wise Distribution under Each Cluster

Table 3- Country-wise Distribution under Each Cluster

Cluster No.	Color Code	No. of Countries	Countries Included
Cluster 1	Red	23	United Kingdom, United States, Canada, Netherlands, Switzerland, Ireland, Italy, Brazil, Sweden, New Zealand, Egypt, Singapore, South Africa, Germany, France, Greece, Colombia, Romania, Czechia, Kazakhstan, Denmark, Spain, Australia
Cluster 2	Green	15	China, Pakistan, Saudi Arabia, India, South Korea, Turkey, Iran, United Arab Emirates, Oman, Lebanon, Kuwait, Qatar, Azerbaijan, Russia, Romania*
Cluster 3	Yellow	7	Malaysia, Vietnam, Indonesia, Taiwan, Lithuania, Bangladesh*, Philippines*
Cluster 4	Purple	6	Australia, Japan, Spain*, Ghana, Russia*, Iran*
Cluster 5	Blue	2	Uzbekistan*, Nigeria*
Cluster 6	Olive/Brown	1	Thailand
Total		54	

Cluster-wise Analysis of Research Fronts

🔴 **Cluster 1 (Red): Global Leaders in Fintech-Driven Sustainability (23 Countries)**

Countries Included: United Kingdom, United States, Canada, Netherlands, Switzerland, Ireland, Italy, Brazil, Sweden, New Zealand, Egypt, Singapore, South Africa, Germany, France, Greece, Colombia, Romania, Czechia, Kazakhstan, Denmark, Spain, Australia.

This is the **largest and most diversified cluster**, reflecting **widespread engagement** across advanced economies and select emerging nations. These countries are characterized by:

- **Strong institutional frameworks** promoting Environmental, Social, and Governance (ESG) transparency.
- **Robust fintech ecosystems**, enabling green investment instruments like green bonds and ESG-integrated funds.
- Emphasis on **disclosure and regulatory alignment**, with a recurring research focus on human-centric fintech applications (e.g., behavior-based sustainable finance).

The co-citation patterns within this cluster suggest a **mature research base**, where nations are not only developing policies but also critically evaluating their impacts. Publications often explore the **interface between fintech and environmental governance**, contributing to theory building and policy design.

🟢 **Cluster 2 (Green): Asian Tech Hubs and Policy Laboratories (15 Countries)**
Countries Included: China, Pakistan, Saudi Arabia, India, South Korea, Turkey, Iran, UAE, Oman, Lebanon, Kuwait, Qatar, Azerbaijan, Russia, Romania
This cluster reveals a **concentrated research front in Asia and the Middle East**, led predominantly by **China and India**. The defining characteristics are:
- **Government-led initiatives** in green finance (e.g., China's green credit guidelines, India's green bond framework).
- Rapid fintech development supported by **state-backed digital infrastructures**.
- Research focuses on **technology platforms, blockchain integration**, and green lending for climate-smart projects.
China dominates bibliometric coupling in this cluster, suggesting it plays a **central role in defining methodological and empirical directions** in the green fintech space. The cluster also reflects an **emerging regional consensus** on digital finance as a lever for sustainable development, particularly in energy transition and climate adaptation.

🟡 **Cluster 3 (Yellow): Emerging Southeast Asian Collaboratives (7 Countries)**
Countries Included: Malaysia, Vietnam, Indonesia, Taiwan, Lithuania, Bangladesh, Philippines
This relatively smaller cluster captures the **rising scholarly interest from Southeast Asia**. While countries like Malaysia and Taiwan have more advanced fintech penetration, others such as Bangladesh and the Philippines are exploring **inclusive digital finance** for sustainability.
- The cluster emphasizes **financial inclusion, renewable energy access, and microfinance integration** into green initiatives.
- Research is largely **exploratory and policy-oriented**, focusing on frameworks for incorporating green criteria into fintech startups, credit schemes, and decentralized finance (DeFi).
This group's coupling indicates potential for **south-south knowledge exchange**, particularly in addressing climate vulnerability using digital innovation.

🟣 **Cluster 4 (Purple): Ecological and Technological Dual Emphasis (6 Countries)**
Countries Included: Australia, Japan, Spain, Ghana, Russia, Iran
This cluster is defined by a **blend of ecological focus and technological application**:
- Japan and Australia, with established clean energy mandates, concentrate on **technological solutions for carbon tracking and renewable finance**.
- Countries like Ghana and Iran are beginning to integrate **green fintech principles into broader developmental goals**.
- Spain and Russia show **dual affiliations** with other clusters, indicating overlapping research interests in both policy and technological domains.
The publications in this cluster often bridge **environmental conservation with AI-driven platforms**, marking a confluence of scientific precision and digital innovation in sustainability finance.

🔵 **Cluster 5 (Blue): Nascent Green Fintech Engagement (2 Countries)**
Countries Included: Uzbekistan, Nigeria
This cluster reflects **preliminary participation** in green fintech scholarship from **emerging economies**. Their inclusion points to:
- **Initial efforts to explore policy potential** and regulatory frameworks for integrating green practices into digital finance.
- Emphasis on **capacity building, regulatory readiness**, and aligning fintech goals with national sustainable development agendas.
Despite the small size, this cluster is **symbolically important**, representing a new wave of countries beginning to engage with the discourse on sustainable finance.

🟤 **Cluster 6 (Olive/Brown): Solitary Regional Contributor (1 Country)**
Country Included: Thailand

Thailand forms an independent cluster, possibly due to **distinct bibliometric characteristics** or **unique national policies** that differ significantly from other countries. This may reflect:

- A focused but **non-aligned research orientation**, with local scholars publishing on specific policy contexts or fintech applications not widely cited elsewhere.
- Potential for this country to **bridge other clusters** as research matures.

Synthesis of Findings

The bibliometric coupling analysis illuminates **three key patterns** in green fintech and sustainable finance research:

1. **Geographic Divergence and Leadership**:
- **Cluster 1** exhibits strong engagement from Western and developed countries, reflecting institutional depth and technological advancement.
- **Cluster 2** shows rising leadership from Asia, especially China and India, indicating a shift in the **epicenter of green fintech innovation**.

2. **Thematic Convergence with Methodological Diversity**:
- While clusters differ in regional composition, they converge on themes like **carbon mitigation, renewable energy, fintech innovation, and disclosure**.
- The presence of **methodological clusters** (e.g., those focused on bibliometric analysis or platform-based approaches) reveals growing **scholarly reflexivity**.

3. **Emerging Research Fronts in the Global South**:
- Clusters 3 to 6 represent emerging geographies (Southeast Asia, Africa, and Central Asia) gradually entering the discourse.
- Their growing bibliometric connectivity suggests **future research diffusion**, especially with global collaborations and policy harmonization.

4.3 Collaboration networks among countries involved in green fintech research, highlighting key contributors and research partnerships

The analysis of collaboration networks among countries engaged in green fintech research reveals a rich tapestry of international partnerships and regional hubs of innovation, underscoring the global and interconnected nature of this emerging field. Out of 107 countries identified, 67 met the threshold of a minimum of five published documents, highlighting a concentrated yet diverse global research engagement.

Figure 3- Cluster-Wise Distribution of Countries with Key Contributors and Partnerships
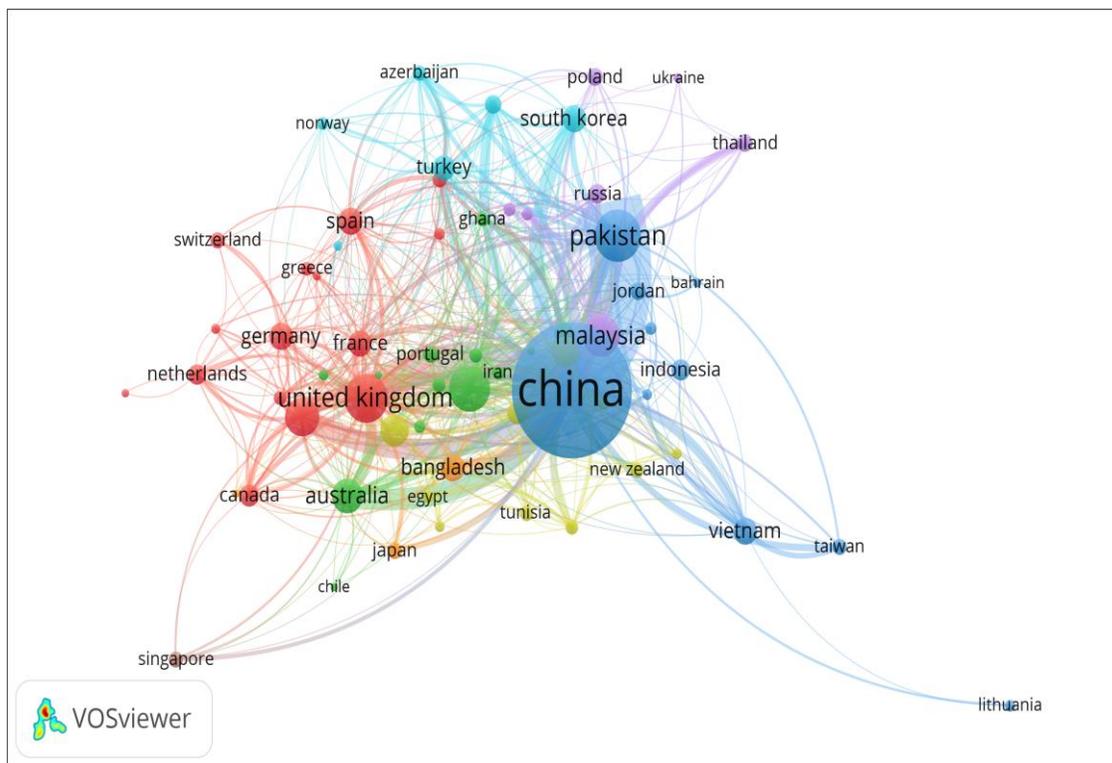
Table 4- Cluster-Wise Distribution of Countries with Key Contributors and Partnerships

Cluster No.	Total Countries	Countries Included	Key Contributors	Notable Research Partnerships
Cluster 1 (Red)	15	Canada, Colombia, Czechia, Denmark, France, Germany, Greece, Kazakhstan, Netherlands, Romania, Spain, Sweden, Switzerland, United Kingdom, United States	**United States, United Kingdom, Germany, France**	Strong transatlantic partnerships; EU collaborative programs (Horizon 2020); academic networks between UK, Germany, and Netherlands
Cluster 2 (Green)	13	China, India, Saudi Arabia, United Arab Emirates, Turkey, Russia, Iran, Pakistan, Oman, Lebanon, Kuwait, Qatar, Azerbaijan	**China, India, UAE**	Belt and Road academic initiatives; cross-border fintech and ESG projects; China-India bilateral sustainability research
Cluster 3 (Yellow)	10	Malaysia, Vietnam, Indonesia, Taiwan, Lithuania, Bangladesh, Philippines, Thailand, Sri Lanka, Myanmar	**Malaysia, Vietnam**	ASEAN-focused fintech development; South-Southeast Asia climate finance partnerships
Cluster 4 (Purple)	10	Japan, Iran, Ghana, Spain, Egypt, South Korea, Nigeria, Italy, Kenya, Portugal	**Japan, Spain**	Japan-Ghana clean energy finance projects; Iran-Spain cooperation on fintech governance
Cluster 5 (Blue)	7	Nigeria, Uzbekistan, Algeria, Tunisia, Morocco, Ethiopia, Zambia	**Nigeria**	Africa-led fintech pilots with support from international institutions;

				regional partnerships through AfDB
Cluster 6 (Brown)	6	Pakistan, Oman, Jordan, Bahrain, Nepal, Maldives	**Pakistan, Oman**	Regional finance summits; joint ventures on Islamic fintech and green microfinance
Cluster 7 (Teal)	3	Lithuania, Taiwan, Estonia	**Lithuania, Taiwan**	Blockchain-enabled sustainable banking projects; Baltic-Asian fintech innovation alliances
Cluster 8 (Grey)	1	**Singapore**	**Singapore**	Solo but specialized research output; high-quality publications and targeted collaborations on green fintech innovation, AI, and carbon credit systems

🟥 **Cluster 1 (Red): Transatlantic and European Leadership**

Cluster 1, encompassing 15 countries primarily from North America and Europe, is characterized by strong leadership from the **United States, United Kingdom, Germany, and France**. These key contributors drive the bulk of research output and establish robust transatlantic partnerships, often facilitated by large-scale EU collaborative programs such as **Horizon 2020**. Notably, academic networks involving the UK, Germany, and the Netherlands foster intensive co-authorship and knowledge exchange, reflecting a well-established research ecosystem that integrates policy-oriented fintech and environmental sustainability frameworks. This cluster's research emphasis tends to align with regulatory innovation, fintech governance, and integration of environmental, social, and governance (ESG) criteria in financial technologies.

🟩 **Cluster 2 (Green): Emerging Powerhouses in Asia and Middle East**

Cluster 2 consists of 13 countries spanning Asia and the Middle East, with **China, India, and the United Arab Emirates (UAE)** as prominent contributors. This cluster is distinguished by active engagement in cross-border fintech and ESG projects, supported by initiatives like the **Belt and Road academic partnerships** which facilitate research collaboration across national borders. The China-India bilateral research ties emphasize sustainable fintech solutions tailored to developing economies, highlighting shared challenges such as financial inclusion and renewable energy financing. UAE's role as a regional fintech hub strengthens the cluster's international connectivity, particularly in integrating Islamic finance principles with green fintech innovations.

🟨 **Cluster 3 (Yellow): ASEAN Regional Cooperation**

The third cluster includes 10 countries primarily from South and Southeast Asia, with **Malaysia and Vietnam** emerging as key contributors. This cluster demonstrates a focused regional collaboration under the auspices of ASEAN, promoting fintech development that addresses climate finance and sustainable development goals. Research partnerships here emphasize region-specific challenges such as climate resilience financing and adoption of digital payment systems for green investments. The ASEAN-focused approach facilitates knowledge sharing on fintech applications for low-carbon economies and rural green finance.

🟪 **Cluster 4 (Purple): Diverse Collaborations Across Asia and Africa**

Cluster 4, also comprising 10 countries, reflects diverse geographical representation with countries like **Japan, Spain, Ghana, and Iran**. Key contributors such as Japan and Spain engage in specialized collaborations—Japan's partnership with Ghana centers on clean energy finance projects, while Iran and Spain cooperate on fintech governance issues. This cluster represents an interesting fusion of developed and developing country partnerships, emphasizing governance frameworks, regulatory innovation, and deployment of fintech for sustainable infrastructure in emerging markets.

🔵 **Cluster 5 (Blue): African Fintech Initiatives**

Cluster 5 is predominantly African, including seven countries led by **Nigeria**. This cluster reveals Africa-led fintech pilots supported by international institutions, with regional partnerships strengthened through organizations like the **African Development Bank (AfDB)**. Research in this cluster focuses on financial inclusion, mobile banking, and green microfinance solutions tailored to local contexts, reflecting Africa's growing prominence in innovative fintech applications with environmental impact.

■ Cluster 6 (Brown): Middle Eastern and South Asian Synergies

Cluster 6 features six countries with **Pakistan and Oman** as leading contributors. This cluster's research partnerships are notably shaped by regional finance summits and joint ventures emphasizing Islamic fintech and green microfinance. These collaborations underscore the integration of cultural and religious finance principles with modern sustainable fintech approaches, addressing unique socio-economic contexts of the Middle East and South Asia.

◆ Cluster 7 (Teal): Baltic and Asian Blockchain Innovation

Cluster 7 is a smaller cluster of three countries—**Lithuania, Taiwan, and Estonia**—that excel in blockchain-enabled sustainable banking projects. Their partnerships highlight cutting-edge fintech innovation, particularly the intersection of blockchain technology with green finance, emphasizing transparency, carbon credit systems, and digital sustainability credentials. The Baltic-Asian alliances formed here indicate strategic positioning in global fintech innovation hubs.

☐ Cluster 8 (Grey): Specialized Solo Leadership by Singapore

Finally, Singapore stands alone as Cluster 8, marked by specialized, high-quality research output in green fintech innovation, AI integration, and carbon credit systems. Despite its solitary cluster status, Singapore's targeted collaborations and focused research niche demonstrate leadership in advancing fintech solutions with environmental impact, reinforcing its status as a global innovation and financial center.

Synthesis of Findings

The global collaboration network in green fintech research illustrates a complex interplay between developed and emerging economies, regional integration, and thematic specialization. Notably:

- **Transatlantic and European countries (Cluster 1)** dominate in volume and institutionalized collaboration frameworks.
- **Asian and Middle Eastern countries (Clusters 2 and 6)** leverage regional and bilateral partnerships to address context-specific sustainability challenges.
- **African countries (Cluster 5)** lead in piloting inclusive fintech innovations with international support.
- **Specialized innovation hubs (Clusters 7 and 8)** focus on blockchain and AI, signaling future-oriented research directions.

The identified clusters demonstrate that research partnerships often align with geopolitical, economic, and cultural proximities, with multilateral programs and summits playing a vital role in fostering cross-border collaboration. These findings highlight the importance of strengthening international cooperation frameworks and capacity-building initiatives to accelerate global green fintech development.

4.4 Top 10 countries with the highest average normalized citation scores (ANCS), highlighting those producing the most impactful and influential research globally

The average normalized citation score adjusts citation counts to account for differences across disciplines and publication years, providing a fair comparison of research impact. By focusing on this metric, the analysis highlights countries whose publications are cited more frequently than average in their respective fields, indicating high research quality and global influence. The dataset containing publication metrics for various countries was analyzed to determine research impact. The metric average normalized citation score was selected to assess the relative influence of research output, as it accounts for citation variations across fields and time. Countries were ranked in descending order based on this metric, and the top 10 countries with the highest scores were identified. This approach enables a comparative evaluation of countries' research quality and global influence. Among 107 countries analyzed, the following ten emerged as producing the **most influential and highly cited research outputs**.

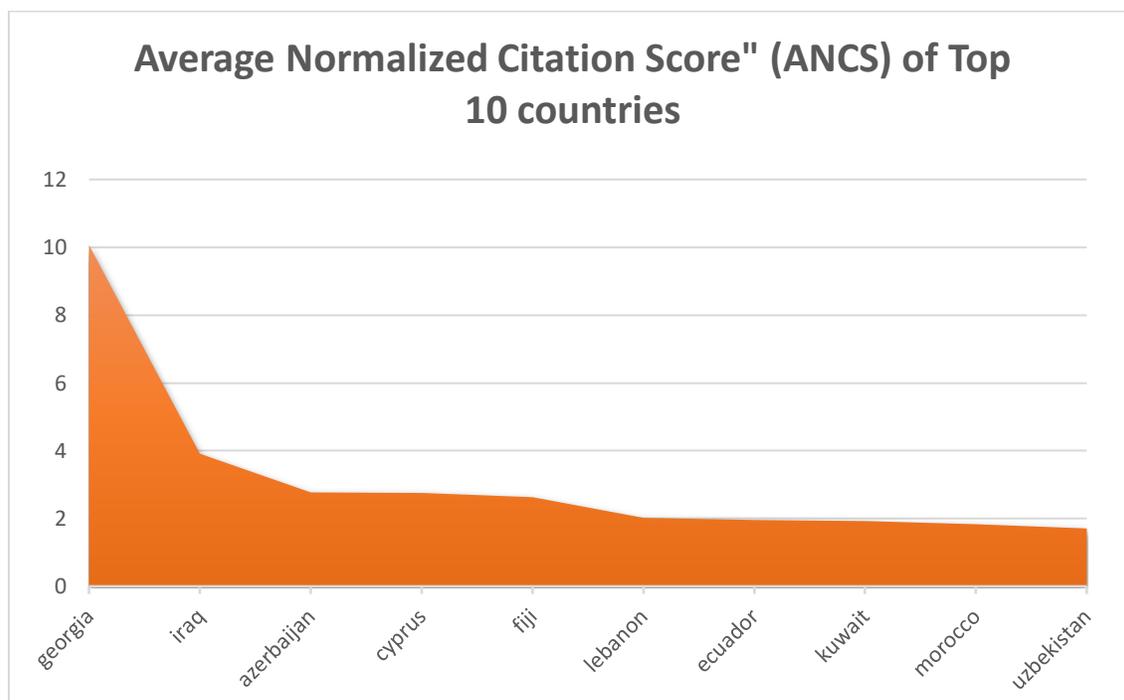**Figure 4- Average Normalized Citation Score" (ANCS) of Top 10 countries**

Average Normalized Citation Score" (ANCS) of Top 10 countries

Table 5- Average Normalized Citation Score" (ANCS) of Top 10 countries

Country name	Average Normalized Citation Score" (ANCS) (score<Avg. norm. citations>)
Georgia	10.0621
Iraq	3.9127
Azerbaijan	2.7758
Cyprus	2.7482
Fiji	2.6226
Lebanon	2.02
Ecuador	1.9539
Kuwait	1.9295
Morocco	1.8356
Uzbekistan	1.7029

- **Georgia** led with an ANCS of **10.06**, indicating that its research in green fintech is cited **ten times more than the global average**, underscoring the **exceptional influence and visibility** of its research outputs. This may be attributed to **targeted niche research**, strong **international co-authorship**, and alignment with emerging global sustainability goals.

- Countries like **Iraq, Azerbaijan, and Cyprus** followed with ANCS values significantly above 2.5. Despite relatively lower publication volumes, these nations demonstrate a **high impact per publication**, suggesting **quality-driven research strategies** and the possible presence of **elite academic networks or specialized think tanks**.

- **Fiji and Lebanon**'s presence in the top five is notable, reflecting **growing academic engagement** from smaller nations often overlooked in global research indices. Their high ANCS scores may result from **focused research on region-specific challenges**, including climate resilience and sustainable development financing.

- **Kuwait, Morocco, and Uzbekistan**—countries from the **Middle East, North Africa, and Central Asia**—further indicate a **geographic diversification** in impactful green fintech research. These regions may be emphasizing **Islamic green finance**, **clean tech entrepreneurship**, and **sustainability-aligned financial systems**.

- The results reveal a trend where **impact does not necessarily correlate with volume**. Most of these countries are **not major publishers by quantity**, yet their research has attracted **significant academic attention**, indicating **strategic relevance, innovation, or policy alignment**.

Synthesis of Findings

The top 10 countries by ANCS underscore a critical shift in the global research landscape, where **emerging and smaller nations** are producing **disproportionately high-impact research** in green fintech. This signals opportunities for **international collaboration**, **funding alignment**, and **capacity building** in these regions. Stakeholders—from policy institutions to research funders—should recognize and **leverage these high-impact contributors** as future hubs of sustainable financial innovation.

5. Discussion and Conclusion

This bibliometric review of green fintech and sustainable financial behavior between 2015 and 2025 reveals a dynamic, rapidly evolving research landscape that reflects the convergence of digital finance and sustainability. The keyword co-occurrence analysis demonstrated that the field has developed along multiple thematic axes, including ESG disclosure, AI-enabled platforms, regional policy innovations (notably in China), carbon mitigation, and renewable energy financing. This multidimensional focus illustrates the field's interdisciplinary foundation, drawing from finance, technology, environmental science, and behavioral economics.

The bibliographic coupling analysis further highlighted how clusters of publications reflect geographic and thematic research concentrations. Western countries, particularly the United Kingdom, United States, and several European nations, have developed mature research ecosystems grounded in regulatory frameworks and ESG-fintech integration. In contrast, countries in Asia and the Middle East, especially China and India, have emerged as innovation hubs experimenting with large-scale digital finance reforms. Southeast Asian and African clusters point toward growing engagement from the Global South, though often in nascent stages of scholarship. These differences underscore the importance of policy context and technological infrastructure in shaping research priorities and outputs.

The collaboration network analysis confirms the global nature of green fintech research, revealing extensive transnational partnerships. The United States and United Kingdom emerged as key global leaders, while regional hubs like China, India, and Singapore are forming their own influential networks. Interestingly, countries such as Nigeria and Uzbekistan, though limited in volume, are initiating meaningful contributions through localized fintech experiments supported by international development agencies. This indicates a shift from knowledge centralization toward broader inclusivity.

Perhaps most striking is the ANCS analysis, which challenges traditional assumptions about research dominance. While the U.S. and China produce high volumes, countries like Georgia, Iraq, and Azerbaijan displayed disproportionately high citation impacts, suggesting targeted excellence, international visibility, or strategic alignment with global sustainability priorities. These findings call for greater academic and policy recognition of emerging research centers in less dominant economies.

Together, the findings point to an increasingly decentralized yet collaborative research ecosystem. The maturity of Western scholarship is being complemented by technological innovation from the East and emerging thought leadership from the Global South. The study confirms that green fintech research is no longer confined to financial innovation but extends to policy, governance, behavioral finance, and climate adaptation.

6. Implications

This study offers practical and theoretical implications for academia, policymakers, and industry stakeholders. For academic institutions and researchers, the mapped clusters and themes provide a foundation to identify underexplored areas—such as the behavioral impacts of green fintech and region-specific digital sustainability solutions. Funding agencies and policymakers can leverage insights from high-ANCS countries to support best practices and foster knowledge transfer between developed and emerging economies. Fintech firms and regulatory bodies can use these results to align their innovation strategies with dominant research fronts, including AI in ESG analytics and blockchain in carbon credit markets. Furthermore, identifying collaborative strengths at the country level can support multilateral environmental finance strategies and global green investment frameworks.

7. Future Directions of Research

Several promising directions emerge for future green fintech research. First, greater integration of behavioral sciences with digital finance is essential to understand how individuals interact with green fintech tools and how these interactions influence sustainable consumption and investment. Second, more work is needed in low-income countries where fintech adoption is rising but scholarly engagement remains limited. Investigating the socio-cultural dimensions and financial inclusion effects

of green fintech in these contexts could yield important insights. Third, longitudinal and cross-country comparative studies could reveal how policy interventions shape technological innovation in sustainable finance. Finally, expanding bibliometric analyses to include grey literature, regulatory documents, and alternative metrics (e.g., social media, altmetrics) would provide a more holistic picture of the field's societal and policy impact.

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