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GREEN FINANCE AND ESG INTEGRATION: PATHWAYS TO ENVIRONMENTAL PERFORMANCE AND CARBON NEUTRALITY

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Abstract

Growing global demands for sustainability and carbon neutrality have made green finance and ESG integration key issues on the sustainable development agenda. However, most research still addresses these two topics separately, resulting in a limited understanding of their combined impact on environmental performance and carbon neutrality. This study aims to identify research developments, map key themes, and construct a conceptual framework explaining the relationship between green finance, ESG integration, environmental performance, and carbon neutrality. This study employs a Systematic Literature Review (SLR) combined with bibliometric analysis of 33 Scopus-indexed articles from 2020 to 2025, selected in accordance with the PRISMA 2020 guidelines, and analysed using Biblioshiny in R Studio. The results indicate that publications have increased rapidly in recent years, but are still dominated by research from China, suggesting opportunities to develop similar research in developing countries, including Indonesia. Bibliometric mapping identified greenwashing, carbon emissions, and financial systems as the most dominant themes in the literature, whilst ESG integration and sustainable finance emerged as rapidly growing areas of study. The literature synthesis indicates that green credit, carbon trading, and green funds have a direct and measurable environmental impact compared to conventional green bonds. This study demonstrates that the relationship between green finance instruments, ESG integration, environmental performance, and carbon neutrality forms an integrated pathway framework that identifies institutional quality, firm characteristics, industry type, and regional conditions as key moderating factors, whilst positioning greenwashing as a systemic risk that may reduce the effectiveness of green finance and ESG implementation in driving the transition towards a low-carbon economy.

Keywords: green finance, ESG, environmental performance, carbon neutrality, bibliometric review

INTRODUCTION

In the context of sustainable development and carbon neutrality, green finance and the integration of environmental, social and governance (ESG) factors are attracting increasing attention. Climate change, environmental degradation and increasing pressure from investors and regulators are driving the financial system towards a more sustainable model. A number of countries are starting to channel capital flows towards greener economic activities, using instruments such as green bonds, green loans, carbon trading and green funds. At the corporate level, ESG integration leads to decisions that are financially driven and are environmentally friendly, socially responsible, and of high quality in terms of corporate governance (Barbosa et al., 2023; Fu et al., 2023; J. Zhang, 2025).

The above findings imply that the transition to a low-carbon economy is not only a technological innovation and environmental policy issue but also a financial issue of the financial system's efficiency of resource allocation (Chen et al., 2024; X. Liu et al., 2025). Green finance is a

means to mobilize investments that reduce emissions and increase resource efficiency. ESG integration is a process that allows companies and investors to consider sustainability risks and opportunities over the long term. At the same time, these two approaches are increasingly being recognized as strategic approaches to support the achievement of sustainable development goals and carbon neutrality commitments adopted by many countries.

The effectiveness of using green finance instruments to reduce carbon emissions, enhance green innovation, and improve enterprises' sustainability performance has been demonstrated (Dai et al., 2025; Li, 2025; P. Wang & Jin, 2025). For example, green credit policies have been found to encourage firms to reduce pollution activities and to increase investment in cleaner technologies. Furthermore, the mechanisms of carbon trading also offer economic incentives to reduce emissions by increasing efficiency and environmental innovation in the operations of companies. In contrast, the ESG literature argues that firms with higher levels of ESG integration are expected to have better environmental governance, greater transparency and better capabilities in managing sustainability risks. Furthermore, ESG integration is linked to enhanced corporate reputation and investor confidence, which can help access sustainable finance (Habib et al., 2025; X. Liu et al., 2025; Nanduri et al., 2025). These results underline the significance of green finance and ESG in transitioning to a low carbon economy.

The existing literature, however, is limited by the fact that most studies analyze green finance and ESG separately and do not explain how the two work together to achieve better environmental performance. In addition, empirical studies in developing countries are relatively lacking because the research is still mostly based on China and some developed countries. In addition, the literature has not fully explained the relation between green finance instruments and ESG integration and environmental performance and the achievement of carbon neutrality. More importantly, there has been no systematic discussion on the potential factors to strengthen or weaken this relationship (Chee-loong et al., 2025; Ghaemi et al., 2025; Perera et al., 2025).

The research gap indicates the need for a study that can synthesize the results from different studies and point to the direction of current research trends. Thus, this study used the Systematic Literature Review (SLR) method, with a bibliometric analysis of green finance and ESG studies from 2020 to 2025. The aim of this research is to map the evolution of the research, identify the main themes that have emerged in the literature and develop a conceptual framework that describes the relationship between green finance, integration of ESG factors, environmental performance and carbon neutrality. This study, based on bibliometric analysis and synthesis of literature, describes research developments and explains the relationships between variables which are the main focus in the transition to a low-carbon economy. The research questions of this study are as follows:

RQ 1 : What are the trends of publication and collaboration network in this field for the past five years?
RQ 2 : What are the thematic gaps between green financing instruments, ESG integration and carbon neutrality outcomes?
RQ 3 : How do green finance instruments and ESG integration interact with each other to influence environmental performance and carbon neutrality? Under what conditions?

Hence, the present study aims to propose an integrated pathway framework to explain the joint effect of green finance instruments and ESG integration on environmental performance and carbon neutrality. It then uses a combination of bibliometric analysis and literature synthesis to give a more holistic picture of research progress, prevailing themes and areas of scholarly neglect. The study also offers practical implications for policymakers, regulators, and managers to create more effective sustainable finance strategies, particularly in developing countries, which face challenges in attaining Sustainable Development Goals and carbon emission reduction targets.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

Green Finance Mechanisms and Green Financial Instruments

Green finance is the allocation of capital to economic activities that have environmental benefits, enabling the transition to a low carbon economy. Green bonds, green loans, carbon trading and green funds are the most common. Green bonds fund large sustainability projects, green loans are financial instruments that push companies to cut environmentally harmful activities, carbon trading provides market incentives to reduce emissions, and green funds invest in companies with better environmental performance (Lu et al., 2025; Sharma et al., 2025).

Some studies claim that green credits have a more direct and measurable effect on the environment than the other instruments. Dai et al. (2025) demonstrated that China's Green Credit Guidelines reduced access to finance for firms in highly-polluting industries and promoted investment in green innovation, thereby improving their environmental performance. Similar results were found for the carbon trading mechanisms that enhanced the green productivity particularly in construction and heavy industry (Lyu et al., 2025). Meanwhile, green funds encourage investors to invest in companies with better carbon performance, thereby improving the economic incentives of sustainable business behaviors (P. Wang & Jin, 2025).

Evidence on the effectiveness of green bonds is more mixed. Ghaemi et al. (2025) remarked that green bonds are closely related to the green economic growth, but the contribution of the green bonds to the environment is not the same for all kinds of green bonds. This risks greenwashing, that is, making claims about sustainability that are not backed up by real changes in operations. The differences of effectiveness of instruments suggest that good quality of policy design, transparency and enforcement of regulations are important factors for the successful implementation of green finance.

ESG Integrations and Corporate Environmental Performance

The implementation of ESG is not a reputation tool but a governance tool that allows companies to unlock long-term value. The implementation of ESG allows the companies to take into account environmental, social and governance characteristics during their decision-making process, which increases competitiveness, improves corporate governance and access to sustainable finance (Barbosa et al., 2023; H. Zhang & Wei, 2024). The governance dimension is the most influential dimension in the decision of the investor followed by the environmental and social dimensions (Lalhunthara et al., 2025). The results suggest that investors are not just interested in the environmental outcomes that companies are providing but also the quality of the oversight and accountability mechanisms that support those outcomes. However, a number of studies indicate that ESG scores do not necessarily correlate to environmental and social performance. This situation may lead to greenwashing whereby firms are able to get high ESG scores without making any necessary changes to their operations (Moussa et al., 2024; Zanten, 2025).

The link between ESG and financial performance isn't a straight line either. Chee-loong et al. (2025) reported the positive impact of higher ESG investments on the economy up to certain extent. Benefits may start to fall off above the optimum and may actually reduce the firm's profits. The findings reveal that the effectiveness of ESG integration depends on the quality of its implementation and the extent to which it aligns with the corporate strategy.

The Capacity for Corporate Carbon Neutrality

Carbon neutrality refers to a condition in which carbon emissions generated by a company's activities are offset through emission reductions, carbon sequestration, or low-carbon investment mechanisms. In recent literature, carbon neutrality is no longer viewed solely as a corporate social responsibility initiative, but also as a strategic operational target requiring substantial financial and technological capacity.

The attainment of carbon neutrality is significantly influenced by the policies of green finance and sustainable investment mechanisms. Dai et al. (2025) find that green financing policies

will assist the adaptation of clean technology and will enhance green innovation in high emission industries. By restricting credit to ecologically damaging activities, firms are motivated to transition to more sustainable production systems, hence enhancing enterprises' ability to reduce emissions (X. Wang et al., 2022).

In addition, green bonds are capital market instruments providing the liquidity required for large-scale carbon neutral projects. Ghaemi et al. (2025) claim that transparency and accurate ESG disclosure are essential to the success of carbon neutralisation. In the absence of a credible reporting framework, carbon neutrality programs might be prone to greenwashing because the environmental claims are not substantiated by structural changes in a company's operations (Nanduri et al., 2025). Hence, literature suggests that carbon neutrality is achieved through the synergy of green finance instruments, severe environmental policies, technical advancement and transparent ESG integration.

RESEARCH METHODS

This study employed a Systematic Literature Review (SLR) approach based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. In addition, bibliometric analysis was conducted using Biblioshiny, a web-based application from the Bibliometrix package in the R environment, to visualise and analyse bibliographic patterns related to green finance and ESG research.

1) Research Design
   This study utilised a Systematic Literature Review (SLR) combined with bibliometric analysis. The SLR followed the PRISMA 2020 guidelines to systematically identify, select, and synthesise articles. Bibliometric analysis was performed using Biblioshiny in R Studio to map publication trends, thematic structures, and research collaboration patterns. The combination of these two approaches will identify research trends whilst synthesising findings regarding the relationship between green finance, ESG integration, environmental performance, and carbon neutrality.
2) Data Source and Search Strategy
   This study utilises the Scopus database as it provides extensive coverage of reputable international publications. The search process applied the following: *("Green Finance" OR "Sustainable Finance") AND ("ESG" OR "Environmental, Social and Governance") AND "Environmental Performance" AND "Carbon Neutrality"*. The search was conducted across the title, abstract, and keywords fields. This research restricted the publication period to 2020–2025 to obtain literature representing the latest developments in green finance and ESG.
3) Article Selection Process
   The initial search yielded 309 articles. After removing 102 duplicate articles, 207 articles remained for the screening stage. Screening of titles and abstracts eliminated 95 articles that did not align with the research focus. Of the remaining 112 articles, 56 were excluded because the full text was unavailable, 21 did not specifically address green finance mechanisms, and 35 did not examine environmental performance or carbon neutrality. This process yielded 33 articles that met the criteria and were used as the analysis sample.
4) Data Extraction and Analysis
   The bibliometric analysis comprised three stages. First, a performance analysis was used to identify publication trends, the countries with the largest research contributions, and the most productive authors. Second, bibliometric mapping was conducted through co-occurrence analysis and thematic mapping to identify key themes and future research opportunities. Third, thematic evolution analysis was used to trace changes in research focus during the 2020–2025 period.

RESULTS AND DISCUSSION

1. Publication Trends and Collaboration Networks (RQ1)

China's dominance in this literature is very high. With a total of 1,940 citations, China leads the field by a very wide margin, far ahead of the United States with 253 and Italy with 191. Japan, although publishing fewer articles, recorded the highest average citations per article at 57.00, reflecting the high impact of its contributions. Indonesia, by contrast, contributes only 6 total citations with an average of 1.50 per article, a figure that speaks volumes about how under-represented the Southeast Asian perspective is in this research agenda that claims to be global.

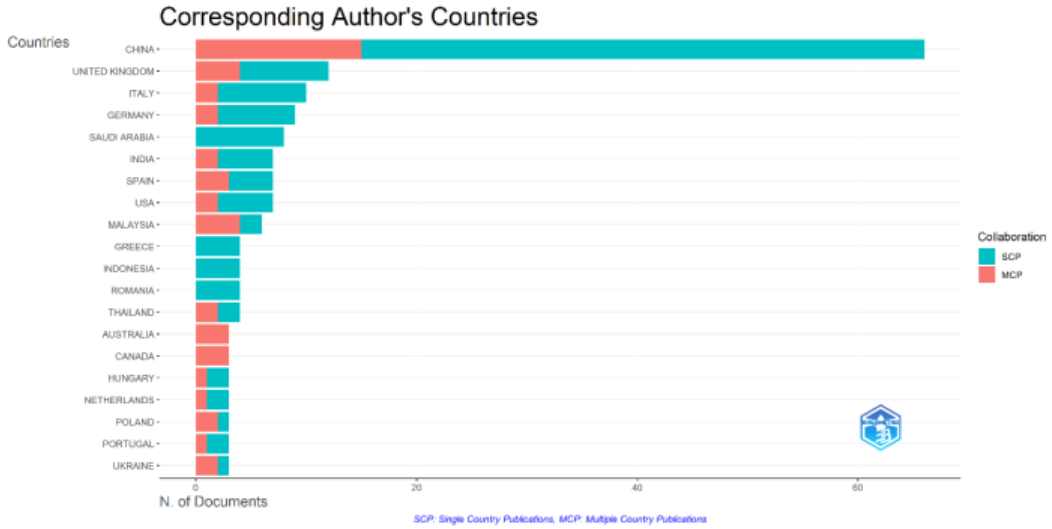

Figure1 . Corresponding Author's Countries

Table1 . Countries with the Most Citations

Country	Total Citations	Average Citations per Article
China	1,940	29.40
United States	253	36.10
Italy	191	19.10
United Kingdom	128	10.70
Japan	114	57.00
Germany	107	11.90
Colombia	78	39.00
Indonesia	6	1.5

The map of international collaboration highlights China's central position within the global research network. The most intensive collaboration occurs between China and several Asia-Pacific nations, such as Australia, Malaysia, Thailand, South Korea and Hong Kong. The UK demonstrates a broader collaborative network spanning various countries across several regions of the world. This pattern indicates that knowledge production in this field remains concentrated in East Asia and Europe; this is where real opportunities lie for researchers from other regions, including Indonesia, to make meaningful contributions.

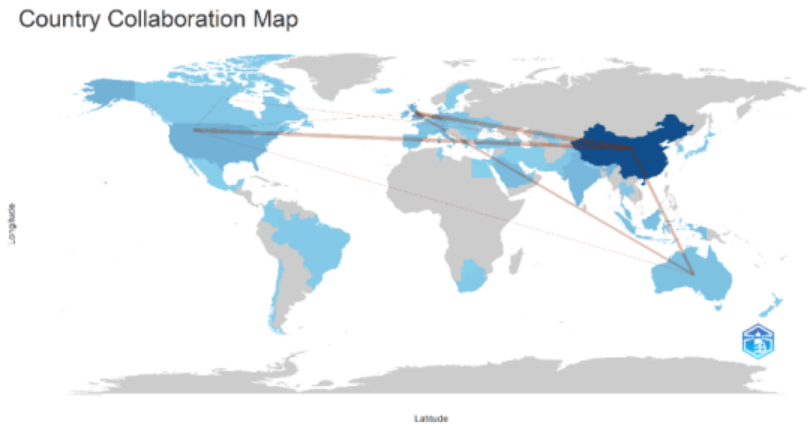

Figure2 . Country Collaboration Map

Table2 . Most Cited Countries

From	To	Frequency
AUSTRALIA	AUSTRIA	14.1264761
	AZERBAIJAN	47.54599879
	EGYPT	29.86190099
	IRELAND	-8.137935687
	JORDAN	36.77136104
	KUWAIT	47.58700459
AZERBAIJAN	CYPRUS	33.0060022
	EGYPT	29.86190099
	JORDAN	36.77136104
	KUWAIT	47.58700459
CANADA	LEBANON	35.88016072
CHINA	AUSTRALIA	134.4910001
	AZERBAIJAN	47.54599879
	CANADA	-98.30777028
	CYPRUS	33.0060022
	DENMARK	10.02800992
	EGYPT	29.86190099
	HONG KONG	114.1138045
	INDIA	79.6119761
	IRELAND	-8.137935687
	JORDAN	36.77136104
	KOREA	127.8391609
	KUWAIT	47,587,004,59
	MALAYSIA	109,697,622
	PAKISTAN	69.33957937
	SPAIN	-3.647550473
	THAILAND	101.0028813
	TURKEY	35.16895346
	UNITED KINGDOM	-2.865631641
	USA	-112.4616737
	UZBEKISTAN	63.14001528
CZECH REPUBLIC	FRANCE	-2.761729445
	HUNGARY	19.39559116
	IRAN	54.27407004
	LEBANON	35.88016072
	PAKISTAN	69.33957937
DENMARK	ICELAND	-18.57396167
	UNITED ARAB EMIRATES	54.3001671
FRANCE	HONG KONG	114.1138045
	JAPAN	138,030.8956
	KUWAIT	47.58700459
	NETHERLANDS	5.28144793
	NEW ZEALAND	171.4849235
	SWITZERLAND	8.208674706
GERMANY	BELGIUM	4.640651139
	CANADA	-98.30777028
	FRANCE	-2.761729445
	JAPAN	138.0308956
	LEBANON	35.88016072
	SWEDEN	16.74558049
	USA	-112.4616737
GREECE	FRANCE	-2.761729445
HONG KONG	AZERBAIJAN	47.54599879
	KOREA	127.8391609
	KUWAIT	47.58700459
	NEW ZEALAND	171,484.9235
HUNGARY	IRAN	54.27407004
	LEBANON	35.88016072
	PAKISTAN	69.33957937
INDIA	AUSTRALIA	134.4910001

From	To	Frequency
	CYPRUS	33.0060022
	ITALY	12,07001339
	MALTA	14.40523316
	POLAND	19,390,128,35
	SAUDI ARABIA	44.53686271
	UKRAINE	31.38326469
	USA	-112.4616737
	UZBEKISTAN	63.14001528
INDONESIA	NEW ZEALAND	171.4849235
IRELAND	BELGIUM	4.640651139
ITALY	BELGIUM	4.640651139
	BRAZIL	-53.09783113
	CYPRUS	33.0060022
	PAKISTAN	69.33957937
	POLAND	19.39012835
	SAUDI ARABIA	44.53686271
	SPAIN	-3.647550473
	USA	-112.4616737
JORDAN	EGYPT	29.86190099
KUWAIT	KUWAIT	47.58700459
	EGYPT	29.86190099
	NEW ZEALAND	171.4849235
LEBANON	IRAN	54.27407004
MALAYSIA	AUSTRALIA	134.4910001
	AUSTRIA	14.1264761
	CZECH REPUBLIC	15,312,401,63
	FRANCE	-2.761729445
	INDONESIA	117.2401137
	IRAQ	43.74353149
	SAUDI ARABIA	44,536,862,71
	THAILAND	101.0028813
	TURKEY	35.16895346
PAKISTAN	DENMARK	10.02800992
	IRAN	54.27407004
	LEBANON	35.88016072
	UNITED ARAB EMIRATES	54.3001671
POLAND	CZECH REPUBLIC	15.31240163
	ISRAEL	35,004,446,93
	UKRAINE	31.38326469
PORTUGAL	CHILE	-71.38256213
	CYPRUS	33.0060022

From	To	Frequency
SAUDI ARABIA	CZECH REPUBLIC	15.31240163
	FRANCE	-2.761729445
	TUNISIA	9.552883589
SOUTH AFRICA	BOTSWANA	23.79853368
SPAIN	FRANCE	-2.761729445
	GREECE	22.95555794
SWEDEN	BELGIUM	4.640651139
TURKEY	DENMARK	10.02800992
	IRAQ	43.74353149
	PAKISTAN	69.33957937
	UNITED ARAB EMIRATES	54.3001671
UNITED KINGDOM	AUSTRALIA	134.4910001
	AUSTRIA	14,126.4761
	AZERBAIJAN	47.54599879
	BELGIUM	4.640651139
	BRAZIL	-53.09783113
	DENMARK	10.02800992
	EGYPT	29.86190099
	FRANCE	-2.761729445
	GERMANY	10.38578051
	HONG KONG	114.1138045
	IRELAND	-8.137935687
	ITALY	12.07001339
	JAPAN	138.0308956
	JORDAN	36,771,361,04
	KUWAIT	47.58700459
	PAKISTAN	69.33957937
	POLAND	19.39012835
	SINGAPORE	103.8172559
	SOUTH AFRICA	25.08390093
	SWEDEN	16.74558049
	TURKEY	35.16895346
	UKRAINE	31.38326469
	UNITED ARAB EMIRATES	54.3001671
	USA	-112,461,673.7
USA	AUSTRALIA	134.4910001
	BELGIUM	4.640651139
	CANADA	-98.30777028
	HONG KONG	114.1138045
	KOREA	127.8391609
	SPAIN	-3.647550473

At the author level, Li X and Wang J were the most productive authors with five publications each, followed by Zhang Y with four publications. The dominance of Chinese researchers is in line with the development of various green finance policies that have made the country one of the main laboratories for the implementation of green finance.

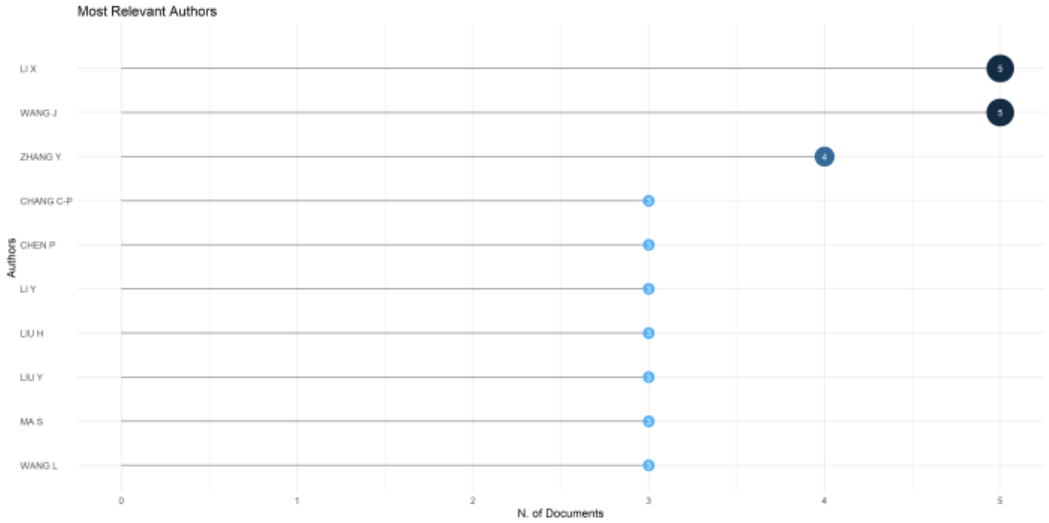

Figure3 . Most Relevant Authors

2. Thematic Structure and Research Gaps (RQ2)

Co-occurrence network analysis grouped the literature into three main clusters. The first cluster centres on ESG, green finance, and sustainable finance, representing core themes in sustainable finance. The second cluster highlights China's role in the development of green finance policies, financial system transformation, and corporate innovation. The third cluster links the concept of the green economy with firm-level factors, such as stakeholder engagement and firm size. The position of sustainable development linking the three clusters indicates an increasingly strong interconnection between financial instruments, governance practices, and sustainability objectives.

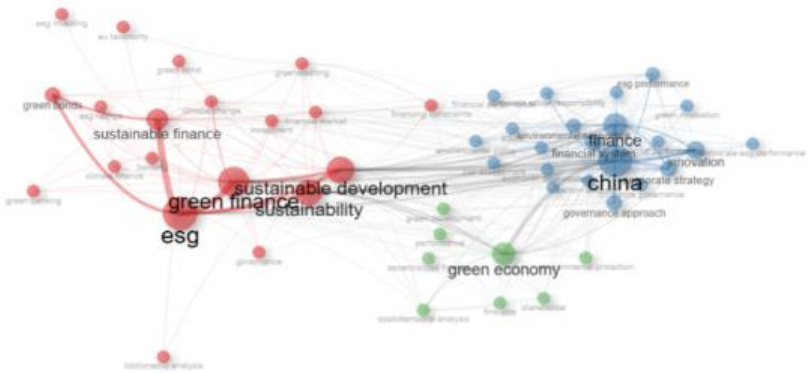

Figure4 . Co-occurrence Network

The results of the thematic mapping indicate that finance systems, greenwashing, and carbon emissions are situated in the 'motor themes' quadrant. This positioning suggests that these three themes possess a high level of development and relevance within the literature. Governance, social, and environmental are situated in the niche themes quadrant, which are developing in depth but have relatively limited connections with other themes. ESG integration, green finance, and sustainable finance are in the emerging themes quadrant, indicating a rise in academic attention over recent years. Meanwhile, green economy, green innovation, and environmental economies remain foundational themes underpinning research development in this field.

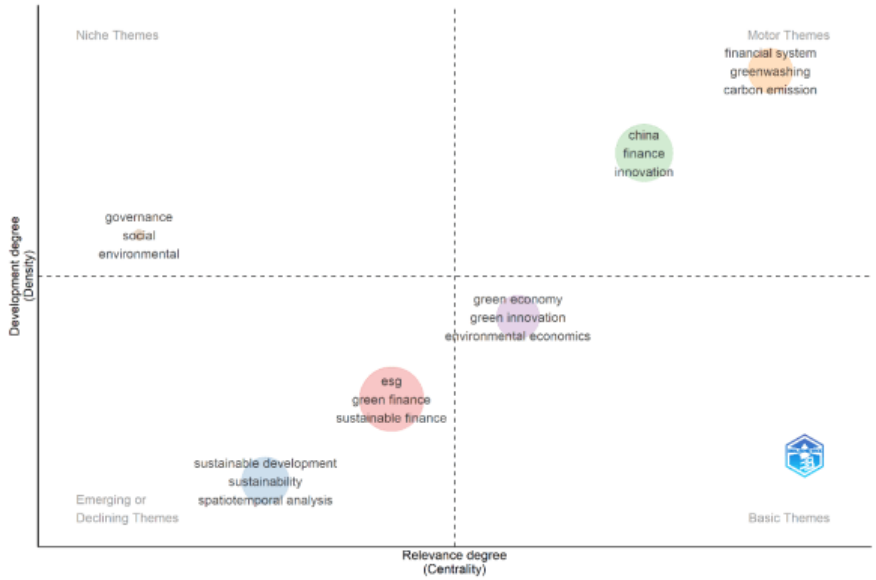

Figure5 . Thematic Map

Table3 . Analysis of the Thematic Map Quadrants

Quadrant	Theme	Meaning
Motor Theme	Financial system, greenwashing, carbon emissions	A theme that is developing well and is a key driver of the research agenda
Niche Theme	Governance, social, environmental	Specialised fields with strong internal development but limited cross-disciplinary connections
Emerging themes	ESG integration, green finance, sustainable finance	A rapidly growing and increasingly strategically important area
Core Themes	Green economy, green innovation, and environmental economies	Fundamental concepts underpinning the entire research domain

The position of greenwashing as a driving theme highlights the growing attention to the credibility of sustainability claims in the implementation of green finance and ESG. This finding indicates that research is no longer solely focused on environmental benefits, but is also beginning to evaluate the risks of misrepresentation of sustainability information. At the same time, the emergence of ESG integration as an emerging theme signals a shift in research focus towards the measurement, implementation, and evaluation of more operational ESG practices.

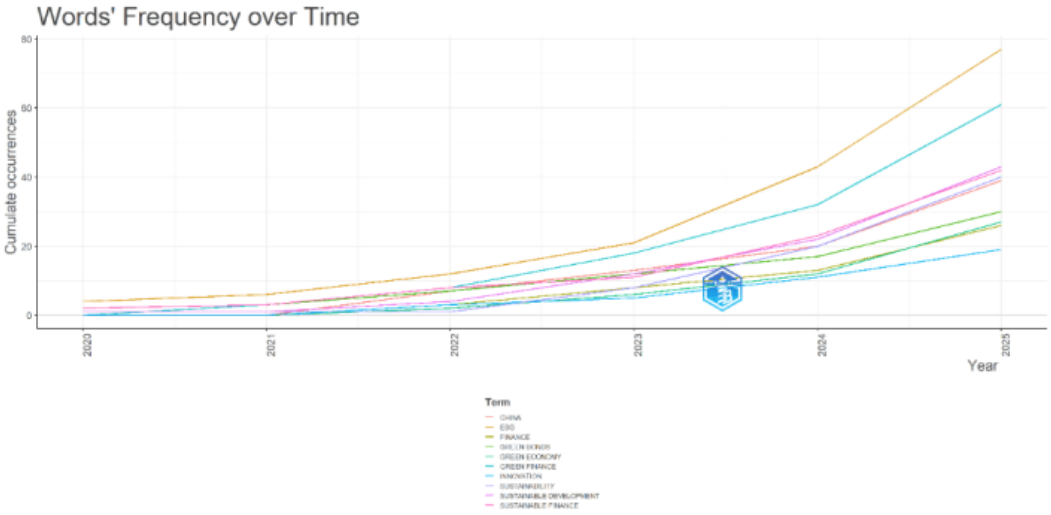

Figure6 . Word Frequency over Time

Thematic evolution analysis reveals a shift in research focus during the 2020–2025 period. In the early phase, research predominantly addressed green finance policies and sustainability issues at the macro level. Entering the 2023–2024 period, research attention began to shift towards ESG performance, the effectiveness of green finance instruments, and corporate sustainability strategies. By 2025, research increasingly emphasised the measurement of environmental impact, carbon emission reduction, and the achievement of empirically verifiable carbon neutrality.

3. Mechanisms, Limiting Factors, and Future Research Directions (RQ3)

3.1 The Impact of Green Finance Instruments on Environmental Performance

A synthesis of 33 articles indicates that green credit is the green finance instrument most consistently associated with environmental performance. These instruments operate through two main mechanisms: restricting access to finance for sectors with high pollution levels and enhancing companies' capacity to invest in green innovation and environmentally friendly technologies (Chen et al., 2024; Dai et al., 2025; Kong et al., 2024; X. Wang et al., 2022). Carbon trading complements these mechanisms through market-based incentives that encourage companies to reduce emissions more efficiently. Several studies indicate that this instrument has a significant impact on the construction and heavy industry sectors (Lyu et al., 2025).

Green funds influence environmental performance through capital allocation mechanisms. Investors tend to direct investments towards companies with better carbon performance, thereby creating economic incentives for companies to improve their sustainability practices (P. Wang & Jin, 2025). Meanwhile, the effectiveness of green bonds shows more varied results. Ghaemi et al. (2025) found that some categories of green bonds are capable of driving green economic growth, but the impact is not always consistent across all categories. These findings suggest that the effectiveness of green finance instruments is highly dependent on the quality of policy design, transparency, and the accompanying accountability mechanisms.

3.2 ESG Integration and Sustainability Outcomes

Most research indicates that ESG integration contributes positively to a company's sustainability performance. Companies that integrate ESG into their business strategies and reporting systems tend to enhance corporate reputation, strengthen investor confidence, and support the achievement of environmental targets and carbon neutrality (Chandra et al., 2024; Lou, 2025; Nanduri et al., 2025; Rammerstorfer & Weinmayer, 2025). The governance dimension

emerges as the most influential component in determining the effectiveness of ESG implementation, particularly in energy-intensive sectors (Lalhunthara et al., 2025).

Nevertheless, several studies have identified limitations in the measurement and implementation of ESG. Zanten(2025) suggest that ESG scores do not always reflect actual environmental and social performance, thereby potentially increasing the risk of greenwashing. Habib et al. (2025) also found that ESG disclosures have a stronger impact when supported by green finance instruments and sustainability-oriented corporate strategies. Furthermore, Chee-loong et al. (2025) demonstrate that the relationship between ESG and financial performance is non-linear, meaning that increased ESG investment does not always yield greater economic benefits.

3.3 Contextual Factors Determining Effectiveness

A literature review indicates that the effectiveness of green finance and ESG implementation is significantly influenced by contextual factors. Companies operating in regions with higher levels of economic development tend to derive greater benefits from green finance policies as they are supported by better infrastructure, innovation capacity, and governance quality (Dai et al., 2025; Ding, 2024; Moussa et al., 2024).

Corporate characteristics also influence the effectiveness of green finance and ESG implementation. Several studies indicate that state-owned enterprises, large-scale companies, and firms in sectors with high pollution levels demonstrate a stronger response to green finance incentives and ESG integration (C. Liu et al., 2024; Tian, 2025). Furthermore, institutional quality emerges as the most dominant moderating factor. Debrah et al. (2022), demonstrate that green finance has a greater impact on carbon emission reductions in countries or regions with strong regulatory and governance quality. Conversely, economic policy uncertainty can reduce the effectiveness of ESG implementation by increasing investment risk and shortening corporate planning horizons (C. Liu et al., 2024).

3.4 Future Research Opportunities

Bibliometric analysis and literature synthesis have identified several open research opportunities. Firstly, research remains dominated by studies in China, meaning that empirical evidence from developing countries, particularly in the Southeast Asian region, remains relatively limited. This situation presents an opportunity to test the effectiveness of green finance and ESG within different institutional contexts.

Second, the relationship between digital finance, fintech, and green finance still requires greater attention. Li (2025) demonstrates that financial technology can amplify the environmental impact of green finance, but the underlying mechanisms of this relationship have not been extensively explained. Third, most research still relies on proxy indicators such as ESG scores and the number of green patents. Future research needs to make greater use of directly measurable environmental indicators, such as verified carbon emission reductions, energy efficiency, or carbon sequestration capacity. Furthermore, empirical research also needs to test the integrated pathway framework proposed by this study across various countries and industrial sectors, particularly ASEAN countries such as Indonesia.

3.5 Integrated Pathway Framework from Green Finance and ESG Integration towards Carbon Neutrality

Based on a synthesis of bibliometric and literature findings, this study develops an integrated pathway framework that explains the relationship between green finance instruments, ESG integration, environmental performance, and carbon neutrality. This framework summarises the key mechanisms identified in the literature and explains the factors influencing the

effectiveness of these relationships. Figure 7 presents the integrated pathway framework derived from this study.

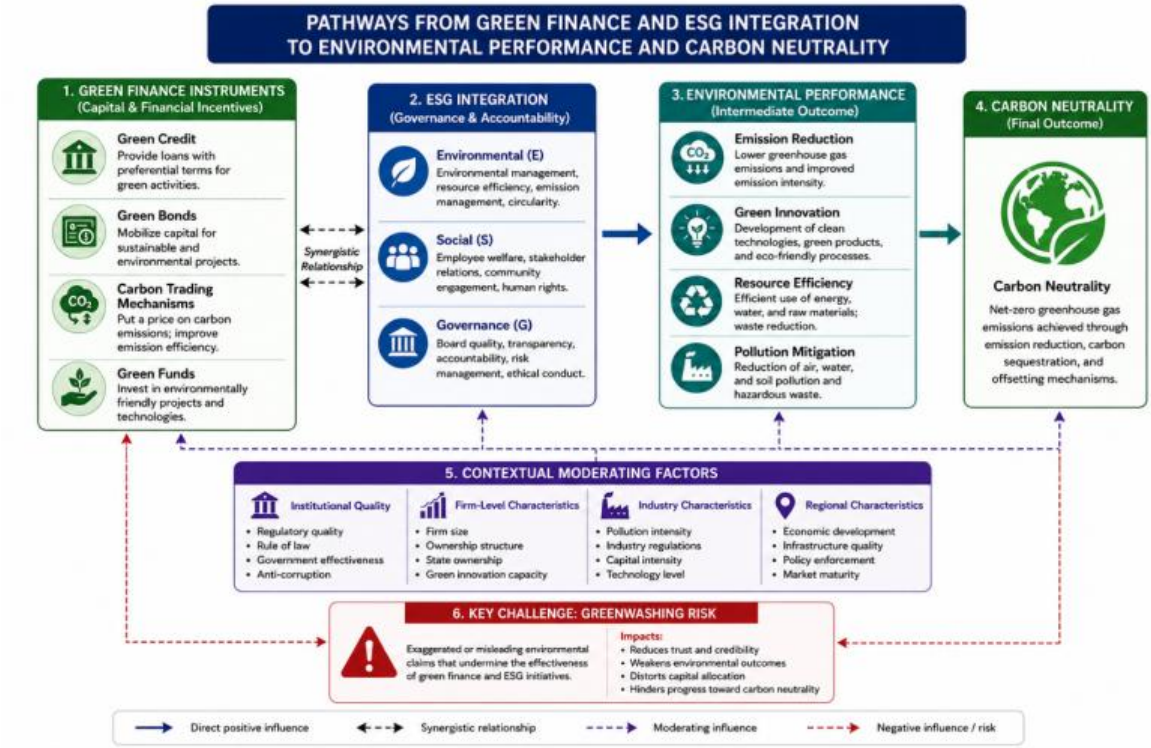

Figure7 . Pathways from Green Finance and ESG Integration to Environmental Performance and Carbon Neutrality

The framework comprises four interrelated key components. The first component is green financial instruments such as green credit, green bonds, carbon trading and green funds; These instruments provide sources of funding and economic incentives to push firms towards more sustainable business practices.

The second element is the integration of ESG, covering the environmental, social and governance dimensions. ESG integration improves the transparency, accountability and long-term orientation of corporate decision-making. The literature indicates that the benefits of green finance are more pronounced when firms incorporate ESG principles in their business strategies and operations.

The third part of the framework discusses the different forms of improved environmental performance that result from the interaction of green finance and ESG integration. The environmental performance is reflected in the reduction of carbon emissions, the increase of green innovation, the improvement of resource efficiency and the reduction of pollution levels. These are the main mechanisms identified in studies through which sustainable finance policies achieve better environmental outcomes.

The fourth element is that carbon neutrality is the ultimate objective, meaning that carbon neutrality is achieved through a combination of emissions reductions, energy efficiency improvements, green technological innovation and carbon sequestration mechanisms supported by sustainable finance and effective governance.

Institutional quality, firm characteristics, industry characteristics and regional conditions are also identified as moderators that influence the strength of relationships between variables in the framework. Moreover, greenwashing is a systemic risk that can undermine the effectiveness of green finance and ESG implementation. Such practices can undermine investor confidence, reduce the quality of capital allocation and diminish the expected environmental impact. Thus, enhancing

the standards of transparency, accountability and disclosure is a prerequisite to expanding the role of green finance and ESG to support the transition to a low-carbon economy.

CONCLUSION

The research results reveal three main findings. Secondly, although there has been a considerable increase of publications on green finance and ESG in recent years, they are still concentrated in China. This indicates that the empirical evidence from developing countries, especially in the Southeast Asian region, is still relatively limited and needs to be paid further attention.

Second, the bibliometric analysis reveals that greenwashing, carbon emissions and financial systems are the dominant themes in the literature. At the same time, ESG integration and sustainable finance have become rapidly growing and increasingly important themes on the sustainability research agenda. These findings suggest a change in research focus from policy debates at the macro level to assessing impacts of implementation and sustainability at the corporate level.

Third, the synthesis of the literature shows that green credit, carbon trading, and green funds have more direct environmental effects than the other instruments. These tools are more efficient when companies incorporate ESG principles into their governance and business strategies. On the other hand, greenwashing practices can reduce the effectiveness of green finance and ESG implementation if not counterbalanced by sufficient transparency and accountability mechanisms.

This study theoretically constructs a framework that links green finance instruments, ESG integration, environmental performance and carbon neutrality through a path. The framework shows that green finance offers incentives and sources of funding while ESG integration improves governance, transparency and accountability. Together the two drives lead to improvements in environmental performance which ultimately support the achievement of carbon neutrality. Institutional quality, firm characteristics, industry type, and regional conditions are moderating factors that influence the effectiveness of these relationships.

The results of this study in practice provide insights for policymakers, regulators, and business actors to formulate more effective sustainable finance strategies. In order to support the transition to a low-carbon economy, it is important to improve the quality of ESG disclosure standards, improve the quality of governance and develop green finance instruments that are appropriate to the local institutional landscape.

The present study has limitations as only Scopus indexed articles were used and the research is dominated by studies from China. Therefore, future research should increase the data sources, broaden the geographic scope of the study, and test the proposed integrated pathway framework in different institutional contexts and industrial sectors, especially in developing countries and the ASEAN region.

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