A Comparative Intellectual and Conceptual Study of Environmental Topic in Economic and Finance

Meilan Yan
Loughborough Business School, Loughborough University, UK

m.yan@lboro.ac.uk

Youwei Li

Hull University Business School, University of Hull, UK

Youwei.Li@hull.ac.uk

Athanasios A. Pantelous
Department of Econometrics & Business Statistics, Monash University, Australia

Athanasios.Pantelous@monash.edu

Samuel A. Vigne
Luiss Business School, Luiss University, Italy

svigne@luiss.it

Dalu Zhang
School of Business, University of Leicester, UK

dz101@leicester.ac.uk

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Abstract

We aim to provide a comprehensive overview of the past, present, and future development of environmental related topics in Economics and Finance. In this regard, Environmental Finance (EF)- and Environmental, Social, and Governance (ESG)-related literature is collected and analysed. The paper draws chronical pictures of the topic development in these two recently developed fields by applying bibliometric methods. Then, we provide a novel systemic comparison on their main differences. Reviewing the top journal publications, we identify literature gaps for a future research agenda. In particular, on the one hand, for EF, we suggest exploring various financial innovations to generate environmental benefits research, and thus building up efficient regulatory framework for addressing major regional and/or global environmental issues. On the other hand, for ESG, we respectively provide potential research directions to conduct the cost-benefit study on the real impact of ESG disclosure and to evaluate how ESG investment strategy efficiently deliver sustainable development.

JEL classification: A10; A12; C88; F64; Q01; Q40; Q56

Keywords: Environmental Finance, ESG, Bibliometric analysis, ESG disclosure and investment

1. Introduction

Since the Industrial Revolution of 19th century, economists started to discuss that unsustainable human enterprises could lead to negative externality for society (e.g., Malthus, 1878; Marsh, 1864; Mill 1848). However, society has just recently begun to recognize the severity of the industrial actions impact on ecological systems. Especially, the concept of planetary boundary as a safe space for sustainable human development (Rockström, et al., 2009) has been widely acknowledged recently by the research communities.[1] The frequent adverse

[1] The planetary boundary identifies the nine thresholds as a safe operating space of humanity. Nine safe operating

environmental changes as consequences of our transgression of the safe operating space have also presented the significant economic impacts and global risks to the society (Stern, 2007; Young & Steffen, 2009). Therefore, it is important for academics to think how economic and finance have been related to environmental topics, and financial innovations can contribute to promote a sustainable economy where humanity lives within the safe zones of our Earth system (Linnenluecke, Smith, & Mcknight, 2016; Hong, Karolyi, & Scheinkman, 2020). Given such fast-growing research interests and potential economic impact, we believe there is necessity to understand this topic in a systematic way to provide comprehensive review over the intellectual and conceptual structure in terms of topical development in Economics and Finance study. Both intellectual and conceptual study are useful tools to review the development of a scientific subject, while the former is based on citation statistics and latter is based on main context and/or keywords analysis.

In the Economics and Finance context, the two mainstreams of literature concerning environment could be categorised: *Environmental Finance* (EF) and *Environmental, Social and Governance* (ESG). In general, EF is an interdisciplinary study area connecting research in finance and the natural sciences to develop market trading mechanisms and/or financial products address some of humanity concerns, such as climate finance, carbon finance, green finance (Linnenluecke, Smith, & Mcknight, 2016). The ESG study normally refers to use the three key factors, *environmental, social, governance*, to measure and contribute to the substantiality of a business model (Friede, Busch, & Bassen, 2015). ESG can also be considered as a framework to assess how a company create the long-term sustainable value in a rapidly changing world associated with environmental, social, and economic changes. Therefore, despite both area of research emphasizes environmental issues, EF tends to closely relate with financial economics and ESG is inclined with focus on financial management.

The aim of this paper is to assist academics understand better the fields of EF and ESG. Our contribution in the existing literature is three-fold. First, we systemically investigate how both topics have been developed, evolved, and expanded by applying bibliometric methods and comprehensive literature review. The second contribution of this paper is to provide the first comparative bibliometric-based analysis to visualise the development of environmental related topics in Economics and Finance. Because of the two-mainstream literature of EF and ESG,

space includes climate change, biosphere integrity, land-system change, freshwater use, biochemical flows, ocean acidification, atmospheric aerosol loading, stratospheric ozone depletion.

we have the opportunity to compare and explore those topics in terms of their intellectual and conceptual structures. Finally, the study identifies a few potential literature gaps of EF and ESG as well as suggests directions for future research.

The remainder of the paper is as follows: In Section 2, the methodology and data description is delignated. Section 3 provides the intellectual structure of EF and ESG by applying bibliometrics analysis. Section 4 describes and compares conceptual structure of ESG and EF in recent years. Section 5 discusses future research questions and agendas in these areas. Section 6 is the final conclusions.

2. Methodology and Data

Bibliometrics is a method to evaluate academic publications (Pritchard, 1969). The findings of Bibliometric study, based on quantitative statistical analysis, can be used to visualize the scope and structure of the discipline and discover the influential authors and main research clusters (Broadus, 1987; Zemigala, 2015; Fahimnia, Sarkis, & Davarzani, 2015). This research technique is also more suitable for academic fields with enormous numbers of outputs, especially in the study of exploring the internal relationship of the literature (Zhao, Zhang, & Kwon, 2018). Bibliometric has been used extensively in life science, operational research, engineering, medicine, and nursing subject areas, but just started to get exposure in Economics and Finance. In the UK, REF 2021 documents suggest this method will be a major and enhanced component in forming submission strategy making by review panels (Corbet, et al., 2019).

Among all data visualization software for bibliometric analysis, Citespace, Gephi, R package Bibliometrix, and VOsViewer can access almost all databases and are friendly users. We use R package Bibliometrics which is developed by Aria & Cuccurullo (2017). The Bibliometix in R language is flexible tool which is often being upgraded and interreacts nicely with other statistical R-packages. It is therefore very useful in a constantly changing science such as bibliometrics. Corbet et al (2019) use R package bibliometrix to surface the main trends and research networks of the financial economics of precious metals from a bibliometric and sociometric perspective. For visualizing the intellectual structure of this topic area, we use graphic network models to present *author collaboration patterns*, *journal citation linkages*, and *keyword connections*. Nodes and edges are two important aspects in graphic network models, where the nodes are individual units of analysis (e.g., authors, countries, journals) and the edges are the links between each node. In this study, the bigger the nodes the higher the degree of centrality

of the individual units of analysis, and the thicker the edges the higher weight of correlation between individual units in the networks. For capturing the dynamic conceptual structure of a topic, we use a combination of approaches in bibliometrics including word clouds, evolution of trend topics, occurrence frequency of keywords, and keyword co-occurrence analysis.

2.1 Data and methodology

The validity of bibliometric analysis for research evaluation largely depends on database selection. Google Scholar (GS), Web of Science (WOS), and Scopus are three major reference and citation-enhanced indexing databases. Even though there is a long debate regarding the choice of data source, each of them has its own advantages and disadvantages. But within Economics and Finance topics, Scopus provides more metrics that leads to richer results due to its broad and inclusive journal coverage nature (Corbet, et al., 2019). Comparing with Google Scholar and Web Science, Scopus offers a more comprehensive reference set and consistent form of author profiles as well as institutional and national affiliation information. Therefore, all data used in this paper are sourced from Scopus. In addition, our data starts at 1990, since data before 1990 is scattered and provides limited impact to the analysis (Michels & Schmoch, 2012; Harzing & Alakangas, 2016). We also keep self-citation information in the dataset, because it does not mispresent our findings as long as the sample is large enough (Corbet, et al., 2019; Waltman, 2016).

In both areas, we select final published articles stage (PUBSTAGE, "final"; DOCTYPE , "ar"; SRCTYPE, "j") between 1990 and 2022 (i.e., PUBYEAR > 1989 AND PUBYEAR < 2023). All documents are limited in Business, Management and Accounting & Economics (SUBJAREA, "BUSI"), and Econometrics and Finance subject areas SUBJAREA ,"ECON"). Following the literature definition of EF, our search strategy of 'title-abstract-keyword' includes *environmental finance*, *climate finance*, *green finance*, and *carbon finance*. Based on the description of ESG, we choose environmental, social, and governance as well as ESG for "title-abstract-keyword" (see **Table 1**).

[Insert **Table 1** somewhere here]

2.2. Overview of the statistics

Table 2 shows the descriptive statistic for our sample. Over the period from 1990 to 2022,

the sample consists of 2114 EF papers and 2734 ESG articles. ESG has larger sample of publications. Those papers are published in a broad selection over 690 of journals respectively. The average citation per documents in EF (24.73) is higher than in ESG (22.4), and the average citations per year per documents between two areas are quite similar (EF is 3.647 and ESG is 3.656). It is also worth noting that the average citation per document is ESG (21.12) is much higher than in EF (6.69) although the average citation per year per documents between two areas are unchanged if we exclude publish year of 2022. This interesting fact suggests that work in ESG might start earlier than in EF while they have similar popularity over the time. The higher terms of author's keywords in ESG (6666) than in EF (5669) reflect the fact that research in ESG is more developed than in EF.[2] The higher terms of Keyword plus in EF (5231) than in ESG (4164) show keywords in EF have been used more in various scientific areas than in ESG.[3] The average numbers of co-authors per documents in EF is 2.6 and in ESG is 2.73, which are higher than mean number of co-authors in the top economics journals standing at 2.2 (Card & DellaVigna, 2013). This indicates high collaborations in EF and ESG related topic areas in economics and finance.

[Insert **Table 2** somewhere here]

3. The intellectual structure of EF and ESG

The intellectual structure of a knowledge domain is a powerful tool for tracking the development of scientific subject based on citation analysis (Chen & Paul, 2001). Following Ramos-Rodríguez et al (2004), we explore the intellectual structures of EF and ESG study by conducting both citations and co-citations analysis on authors, countries, and journals.

Table 3 lists top ten authors in each of the filed in terms of production. Taghizadeh-Hesary

2 Author Keywords consist of a list of terms that authors believe best represent the content of their paper (Zhang, et al., 2015).

3 Keywords Plus are words that appear frequently in the titles of an article's references but not necessarily in the title of the article Keywords Plus terms capture an article's content with greater depth and variety of scientific fields, but less comprehensive than author keywords (Zhang, et al., 2015).

F. appears to contribute most in terms of numbers of publications, while Zhang D.[4] is the top individual contributed author in EF. In ESG, Li Y. has highest number of publications and Buallay A. is the top individual contributed author. Comparing with the number of articles of top authors, we can observe that the average output of top author in EF study is 9.0 papers, however, the average output of top author in ESG study is 8.6 papers. From the numbers of article fractionalized, most top authors in EF have around 3.2, while in ESG have around 4.2 of outputs. This shows that those top authors' contribution to ESG is also higher than the contribution from top authors to EF.

[Insert **Table 3** somewhere here]

Table 4 shows the top 10 journals of publication. It appears that outputs are concentrated in several journals. Majority articles of both areas are published in 5 journals: *Journal of Cleaner Production, Ecological Economics, World Development, Journal of Sustainable Finance and Investment, Business Strategy and the Environment*. Some distinctive publishing characteristics can also be shown. EF articles are published in economics journals (e.g., *Energy Economics, Environmental and Resource Economics*), while ESG papers are published in management policy related journals (e.g., *Marine Policy, Corporate Social Responsibility and Environmental Management*). The difference between choice for publication also indicates distinctive research themes in two areas. In addition, most these journals are not mainstream economics or finance journals, this suggests that the study of EF and ESG is an area that is somewhat scattered, in terms of number of publications and the choice of journals for publication. This may be due to the fact that that those topical explorations might start in other scientific fields then merge into Economics and Finance in recent years.

[Insert **Table 4** somewhere here]

Table 5 shows top 10 national concentrations of authorship. The dominant locations are developed countries and the US tops the list. Although China lists as the second most productive country in EF study and the third most productive country in ESG, it is not surprise that there is a lack of related research produced by other developing countries. Preference for rapid

[4] We add first initials for authors mentioned in the paper with same surnames.

corporate growth over management quality in emerging markets as a potential reason for this research gap (Kurtz, Cooper, & Shimada, 2012). **Table 6** summarise top 10 national concentrations of citations. In terms of total citations, the US and UK are the top cited countries in both EF and ESG studies. With regard to average article citations in EF research, Turkey has the highest over 65 followed by Spain (44.11) and the US (38.14), which might suggest Turkey has produced several high popular papers. In respect of average article citations in ESG study, the US, the UK, Germany, and Netherland have number over 35.

[Insert **Table 5** somewhere here]

Despite China is one of the most productive countries, the popularity of those papers still quite low given the average citation of China in both EF and ESG studies are below 20.

[Insert **Table 6** somewhere here]

Table 7 lists the most cited papers in the field. Three papers Cheng (2014), Terjesen (2009), and Renneboog (2008) have been listed in both research areas. The range of total citations and total citations per year in EF papers are higher than ESG paper. This suggest that although there are less EF papers published in the sample period, the popularity of EF articles might be higher than ESG papers. From the journals of the top cited papers, we can see the citation sources in both areas are quite mixed, combined with several management journals and economics journals.

[Insert **Table 7** somewhere here]

Figure 1 and **Table 8** show bibliometric coupling for co-authorship pattens across countries and country members of clusters. For limiting the amount of visual clutter, we also focus on countries that have published 5 or more papers.[5] Country members of co-authorship clusters are coloured in **Figure 1** and listed in **Table 8**. **Figure 1** illustrates the co-authorship pattern

[5] We follow Corbet et al (2019) to analyse the most impactful trends.

across countries. The largest clusters of co-authorship in EF research are centred in the US, then the UK and China. The largest clusters of co-authorship in ESG study are centred in the US and Italy. Table 8 presents the groups of country members clusters. In EF research, country collaboration has been split into 5 clusters. It is interesting to note that authors from three largest cluster centres, the US, the UK, China, do not collaborate much closely between each other. China (cluster 1) connects with Pakistan, New Zealand, and Ireland. The US (cluster 2) forms close link with Australia, Italy, and Netherlands. The UK (cluster 5) relates to Switzerland, and South Africa. In ESG study, country collaboration has been split into 2 clusters. The USA (cluster 1) closely works with the UK, China, and Australia. Italy (cluster 2) links with Germany, France, and Spain.

[Insert **Figure 1** somewhere here]

[Insert **Table 8** somewhere here]

Figure 2 shows the co-authorship patterns across individual authors, with the threshold set at the minimum of 4 publications. Comparing the collaboration pattern between two areas, the author collaboration in EF research is not only much closer than ESG but the link between each different cluster in EF is also quite closer than ESG. EF related topics have 5 research groups. The centre author in each group is also the top author listed in **Table 3**. One cluster closely around Taghizadeh-Hesary F.; the other one around Wang Y.; the third one around Li Y.; the fourth one around Moneva J. M.; the fifth one around Zhang D.. Although it is clear to see the collaboration network is more scattered in ESG study, there are still 4 high concentrate research groups. One cluster closely around Li Y.; the other one around Crifo P.; the third one around Gallego-Alvarez I.; the fourth one revolving around Wang Z.; and fifth one around Gangi F..

[Insert **Figure 2** somewhere here]

Figure 3 and **Table 9** present journal coupling patterns. Bibliometric coupling describes the common reference sets between two articles or domains. There are two journal clusters in EF. "Journal of Cleaner Production" is the centre of first cluster (cluster 1 in **Table 9**, red cluster in **Figure 3A**). It closely links with Ecology and Management journals such as "Business

Strategy" and "The Environment and Ecological Economics". "Energy Economics" is the centre of the second cluster in EF (it is the biggest cluster in EF, cluster 2 in **Table 9** and blue cluster in **Figure 3A**). It is coupled with majority members of Economics and Energy related journals, for example, "Journal of Sustainable Finance and Investment", "World Development", and "Forrest Policy and Economics".

There are two journal clusters in ESG. "Journal of Cleaner Production" is the centre of the first cluster (cluster1 in **Table 9** and red cluster in **Figure 3B**). It connects with more Finance related journals such as "Business Strategy", "the Journal of Business Ethics", and "the Journal of Business Research". "Journal of Sustainable Finance and Investment" is the centre of the second cluster in ESG (blue cluster in **Figure 3B** and cluster 2 in **Table 9**). Other productive journals in this clusters include "Environment, Development and Sustainably", "Finance Research Letters", and "Journal of Portfolio Management".

[Insert **Figure 3** somewhere here]

[Insert **Table 9** somewhere here]

4. The conceptual structure of EF and ESG

Beyond the citation statistics analysis, we investigate conceptual structure of EF and ESG to understand the topic trends within each research area, based on main context or keywords analysis (Moss, Tyler, & Taylor, 2007).

We recognize that there are studies which can be categorised in both EF and ESG areas. However, there will also be some different features of each area. To visualise these distinctive and overlap features, we combine Venn diagram with word cloud analysis. Firstly, we draw Venn diagrams to shows word clouds for abstracts and keywords for both EF and ESG in top 200 frequency terms (see **Figure 4**). The word size represents the mention frequency, which means the bigger the size, the higher the frequency of the word. The intersection part of EF and ESG in **Figure 4A** presents the overlapped research topic mentioned in paper abstracts including social, environmental, governance, corporate, performance, sustainability, development, economics, etc. Specific abstract words in EF are included in *finance*, *emission, banking,*

funding, cost; while in ESG included in *esg, responsibility, disclosure, stakeholder, boards*. The intersection part of EF and ESG in **Figure 4B** presents the overlapped research topic mentioned in keywords including *climate, investments, technology, organizational, environment*. Specific abstract words in EF are included in *bond, carbon, debt, modelling, technological, globalization*; while in ESG included in *ethics, diversity, ecology, politics, shareholder, transparency*. Such difference word frequency in two areas also reflect distinctive research focus on which EF is more related in finance while ESG is in management. From the above, it can be shown that EF topics are more distinctively focus on financial terms, while ESG more incline with management.

[Insert **Figure 4** somewhere here]

For visualizing the recent trend of topical development dynamic, we firstly calculate the median year for each keyword since 2010, and we choose the top 3 keywords in each year with minimum frequency of 3. Based on the term frequency of collected keywords, we draw on the evolutionary topic trend on the bar chart in **Figure 5**. The length of the bar presents the first and last point of the mentioning the keyword. For example, *social responsibility* from EF started around 2005 but lost its popularity after 2013.[6] *Community forestry* from ESG started around 2008 but lost popularity after 2014. The dot in each line is the medium of the term frequency, and the size of the dot represent the level of the attention of this topic. The range term frequency in ESG ([100, 200]) is quite bigger than in EF ([25, 100]), which echoes the larger research scale in ESG than in EF.

[Insert **Figure 5** somewhere here]

Certain research trends in EF and ESG can also be observed from **Figure 5**. Before 2013, EF study more focused on economics perspectives including *environmental economics*, *regulation*, and *global warming*. Between 2013 and 2016, EF related topics were in management, especially in *corporate governance* and *environmental management*. After 2016, it emerged

[6] Social responsibility is different from corporate social responsibility.

into finance topic such as *climate finance*, *green finance and investment*, and *sustainable finance*. However, before 2013, ESG research started in environmental dimension including *ethical investment, stakeholder*, and *globalization*. Between 2013 and 2016, it moved to social dimension especially in *social responsibility*, *corporate responsibility*, *regulation and ethics*, *institutional responsibility*. And after 2016, it shifted towards *governance dimension* and also started to combine all *environmental, social*, and *governance* factors together. This will be further discussed in Sections 4.1 and 4.2.

Secondly, we plot the frequency of overall top 10 keywords occurrence from 1990 to 2022 (see **Figure 6**). The frequency of keywords in EF are volatile, such as *climate change*, *sustainability*, *financial performance*, *climate finance*, has grown much slowly before 2010 but jumped rapidly afterwards, which shows that this topic area has started to receive most attention in the recent years. The keyword growth trend in ESG is less volatile than in EF, however, topics such as *corporate social responsibility*, *sustainability*, and *governance* start to gain more attention after 2015.

[Insert **Figure 6** somewhere here]

Figure 7 represents the keyword co-occurrence networks. In EF, the central keyword co-occurrence nodes including, *sustainable development*, *financial performance*, and *climate change*. "Sustainable development" topic connects with environmental management, decision making, pollution control (cluster in red, **Figure 7A**). "Financial performance" topic relates with financial system, green finance, financial development (cluster in blue, **Figure 7A**). "Climate change" topic links with carbon emissions, renewable energy, emission control (cluster in green, **Figure 7A**). In ESG, the central keyword co-occurrence nodes including, *governance approach* and *sustainable development*. "Governance approach" topics relates to corporate social responsibility, climate change, stakeholders, investment (cluster in red, **Figure 7B**). "Sustainable development" topic connects with economic and social effects, environmental protection, public policy, emission control (cluster in blue, **Figure 7B**). These findings are also consistent with the analysis of word clouds (**Figure 4**).

[Insert **Figure 7** somewhere here]

From the results of topic trend and keyword occurrence analysis, we can see periodical development to both research area. In the following two subsections, we will solely review key literature in the different periods.

4.1 Environmental Finance

4.1.1 Economics dimension: global policy and regulation (-<2012)

Before 2012, environmental finance study more focused on the discussions of environmental economics, regulation, and global warming. For example, Klassen (1996) proposes a theoretical model to prove a strong environmental management could improve future financial performance. But Rassier & Earnhart (2010) provide empirical evidence that more stringent US Clean Water Act regulation undermines expected future financial performance. Laurent-Lucchetti & Leach (2011) develop a theoretical model to indicate unequal distributional implications of climate policies on generational welfare. Lopez-Gamero et al (2010) evaluate the relationship between managerial perception and the different styles of environmental regulations.

4.1.2 Management dimension: corporate social responsibility (2013-2016)

From 2013 to 2016, EF research is closely related with corporate social responsibility topics. Cheng et al (2014) provide evidence that superior performance on CSR strategies could lower company's capital constraints and lead to better access to finance. Chava (2014) finds that firms with environmental concerns have higher cost of capital. Casey & Grenier (2015) provide an empirical examination of the CSR assurance market in the United States. They find that highly regulated companies are more likely to obtain CSR assurance, but highly leveraged firms are less likely to obtain CSR assurance. Lee et al (2016) also show significant positive relationships between environmental responsibility and corporate financial performance of Korean firms in early 2010s.

4.1.3 Finance dimension: climate change, green finance, financial performance (2016>-)

From 2016 up to now, EF related literature has moved to finance dimension such as climate

change, green finance, and financial performance. For instance, Geddes and Schmidt (2020) provide empirical analysis of the role of finance in re-directing the development of new technological practices. Cojoianu et al (2020) exam how different type of environmental policies affect the financing of green (low carbon), brown (fossil fuel) and grey (unrelated to natural resources) industries. Ren et al (2020) find the role of green finance in carbon mitigation. Bressan & Romagnoli (2021) exam the climate and weather derivatives as instruments to hedge climate risk as well as their implication for financial stability. Braga et al (2021) provide empirical evidence that governments and multilateral organizations can de-risk green investments by supporting the issuance of green bonds. Leitao et al (2021) prove that green bonds are underlined in determining the behaviour of the European Union carbon markets with greater persistent effect than conventional bonds and energy commodities. Huij et al (2021) propose, carbon beta, as a market-based proxy to measure for climate risk.

4.2 ESG

4.2.1 Environmental dimension: ethics and globalization (-<2012)

Before 2012, ESG research are more focused on ethical investment, stakeholder, and globalization. For example, Halter & de Arruda (2009) assess the consistency of transnational companies in their home and host countries, concerning ethics values and social responsibility. Eccles & Viviers (2011) reflect the ethical investment practice mentioned in the academic literature from 1975 to 2009. They show that ethical investment is significantly more frequently used in journals dealing with ethics, business ethics and philosophy than in finance, economic and investment journals in the sample period. In terms of stakeholder interests, Coleman (2011) provides empirical evidence that firms' sales margin will be hurt by unethical treatment of stakeholder. Fransen (2012) exams the effect of various policy attempts on global environmental issues. They argue that legitimation politicking is a divergence between the surface appearance of the governance of programmes and the programmes' actual institutional design.

4.2.2 Social dimension: institutional responsibility (2013-2016)

From 2013 to 2016, ESG research especially increases attention in examining industry corporate strategy as well as the significant economic and social consequences. For example, Singal (2013) examines the link between sustainability and economic performance for the hospitality industry. Martinez-Ferrero & Frias-Aceituno (2015) clarify the relationship between

companies' sustainable behaviour and their financial performance from 25 countries. Stellner et al (2015) exam the link between corporate credit risk ratings and their non-financial performance results. Shaukat et al (2016) develop a theoretical model to explicit the link between CSR related board attributes to financial performance. And Sethi et al (2016) analyse the link for 48 of the world's largest corporations in the extractive industry.

4.2.3 Governance & ESG dimension (- >2017)

After 2016, ESG related literature shifted from to governance dimension and starting to combine all ESG factors. For instance, Li et al (2017) find a positive association between ESG disclosure level and firm value. Kim et al (2019) study the role of institutional investors influences corporate ESG policies. Engle (2020) model climate risk exposures by using firms' ESG scores and hedge climate change risk in a mimicking portfolio approach. Ni & Sun (2018) evaluate different governance mechanisms against the level of environmental dynamism and stakeholder pressure. Nguyen et al (2020) provide empirical evidence that environmental financial accounting practices improve financial performance. Bologensi & Nahrath (2020) propose a new theoretical explanation that transversal transaction costs (TTCs) as a critical source of governance failures. Phelps et al (2021) provide empirical evidence that experts preferred solutions are distinct from resource users' governance measures. Another significant trend of study is in sustainable asset pricing topic embedding ESG factors. Pedersen et al (2020) compute the empirical ESG-efficient frontier and show the costs and benefits of responsible investing. Avramov et al (2021) apply an equilibrium model accounting for ESG demand and supply dynamics. They find that in equilibrium., ESG preference shocks associate with positive risk premium. Berk & Binsbergen (2021) find no evidence that the ESG divestiture strategies could increase the cost of capital of firms, so they suggest socially conscious investors should increase their impact in term of control to change corporate policy. Golstein et al (2022) develop a rational expectations equality model in which an improvement in the ESG information quality can raise green investors' cost of capital. Ardia et al (2022) show that green firms outperform brown firms when concerns about climate change increase unexpectedly. Faccini et al (2021) exam whether climate risk factors are reflected in US stock prices. They find out only climate-policy factor is priced but not natural disaster, global warming, etc. Pastor et al (2021) exam the outperformance of green assets in recent years reflects unexpectedly strong increases in environmental concerns, not high expected returns. Based on recent political fights between ESG believers and deniers, Edmans (2022) responses that ESG is extremely important but

nothing special, since it is no better or worse than other intangible assets to drive long-term value and create positive externalities for wider society. Instead, reasonable people can disagree and learn from each other about the factors that create long-term value for both shareholders and society.

4.3 Top journal topical review

The highest rank journals present world-leading impact in terms of originality, significance, and rigour; therefore, we believe that papers accepted by those journals could inspire future research direction. In order to review these high impact papers, we follow the Chartered ABS Journal Guide 2021 to review all papers have been published in the highest rank (4*) journals in Accounting, Economics, Finance, and Management from 1990 to 2020.[7] Those journals are also listed in the top rank (A*) by other institutions such as Australian Business Deans Council (ABDC) as well as German Academic Association for Business Research (VHB).

From **Table 10**, there are 38 EF papers and only 25 ESG papers published in the listed top journals in the sample period which might also suggest the significance of EF papers are higher than ESG articles. It is interesting to mention that two papers related to corporate social responsibility (Cheng, Ioannou, & Serafeim, 2014; Kölbel, Busch, & Jancso, 2017) are in both searching criteria.

It is also obvious that organization and management journals have the greatest number of publications in this topic. "Strategic Management Journal*"* is the most productive source which has 5 EF papers and 6 ESG articles. "Management Science*"* has 5 EF papers and 2 ESG articles; "Research Policy*"* has 7 EF papers and 4 ESG articles; "Journal of Operations Management*"* has 4 EF papers and 2 ESG articles. However, the publications in Economics and Finance journals are quite limited. Only 3 EF papers are published in "Journal of Finance*"*, 2 EF papers are published in "Journal of Financial Economics*"*, and 1 paper is published in "Review of Financial Studies*"*. While there are only 3 ESG articles are in "Review of Financial Studies*"* and 1 ESG article on "Journal of Accounting and Economics*"*.

Among the EF papers, Klassen & McLaughlin (1996) develop a theoretical model to test

[7] For detailed journal ranking list, please follow the link: https://charteredabs.org/academic-journal-guide-2021/

the positive link between strong environmental management and the firm future financial performance. While Lefebvre et al (1997) provide empirical evidence that firm aggressive technology policy leads greater positive performance than CEO's environment perceptions or business orientations. Barnett & Salomon (Placeholder1) suggest further in-depth examination of the impacts of different social screening strategies could increase financial performance. Richard et al (2007) document a U-shaped relationship between racial diversity and firm productivity. The positive relationship is stronger in service-oriented relative to manufacturing-oriented industries and in more stable vs. volatile environments. Germain et al (2008) show that supply chain process variability has an inverse relationship with financial performance, regardless of the demand environment. Jacobs et al (2010) analyse the shareholder value effects of environmental performance by measuring the stock market reaction associated with announcements of environmental performance. Carmona & Hinz (2011) use a simple risk-neutral reduced from model to price European call options with CO2 emissions constraints. Chava (2014) argue that exclusionary socially responsible investing and environmentally sensitive lending can have a material impact on the cost of equity and debt capital of affected firms. Cheng et al (2014) provide evidence that both better stakeholder engagement and transparency around CSR performance are important in reducing capital constraints. Ortiz-de-Mandojana & Bansal (2016) argue that the social and the environmental practices associated with business sustainability contribute both short-term outcomes as well as long-term organizational resilience. Suanter et al (2022) develop a method to capture the proportion of the earnings call cantered on climate change topics. Their measures are helpful in predicting important real outcomes related to the net-zero transition, notably green tech growth and green patenting. Hsu et al (2022) study the asset pricing implication of industrial pollution. They find that the growth of environmental litigation penalty could help price the cross-section of emission portfolios' return.

Within ESG papers, Kolbel et al (2017) show that negative media articles regarding environmental, social, and governance (ESG) issues increase a firm's credit risk. Flammer et al (2019) find that CSR criteria in executive compensation mitigates corporate short-termism and improves business performance. Kim et al (2019) studies the role of institutional investors in influencing ESG policies by analysing the relation between institutional ownership and toxic release. Fu et al (2020) provide empirical support for the positive association between firms' R&D intensity and CSR specialization. Engle et al (2020) propose a procedure to dynamically hedge climate change risk by using firms' ESG scores. Larcker & Watts (2020) provide empirical support that in real market settings investors appear entirely unwilling to forgo wealth

to invest in environmentally sustainable projects. Gualandris et al (2021) document that supply chain density positivity associate with supply chain transparency in the context of the collective public ESG disclosures. Bolton & Kacperczyk (2022) show investors are already demanding compensation for their exposure to carbon emission risk. Pastor et al (2021) indicate that investing produces positive social impact by making firms greener and by shifting real investment toward green firms. Flammer (2021) show investors tend to increase in long-term ownership on corporate greed bonds. Avarmov et al (2022) suggest ESG uncertainty is an important barrier to sustainable investing.

[Insert **Table 10** somewhere here]

5 Open research questions and future research agenda

Our bibliometric analysis does not only present the past and present development of study in EF and ESG, but also help to identify research gaps and new research topics. Based on the results discussed in previous sections, we highlight a few directions for future research in these two areas.

5.1 For EF: Climate finance and green finance

The growing topics in EF focus on applying climate integrated financial innovation to improve financial stability and environmental regulation frameworks. However, limited studies have explored financial products embedded with other natural risks such as land loss, water pollution, and fatal pandemics. Therefore, we suggest research agenda in EF at least in three directions. Firstly, researchers are encouraged to explore the use of various financial innovations to attract more investments to provide environmental benefits. Secondly, there is an immediate need to proactively measure risks of environmental financialization, for example whether traditional financial asset pricing models could be useful to capture the volatility of green finance products. Thirdly, an important issue for further researcher to discuss how to establish efficient regulation framework to tackle regional or global ecological issues, or how to tailor environmental protection schemes in either developing or developed countries.

5.2 For ESG: ESG disclosure and ESG investing

The majority of ESG research look in the role of ESG scores on corporate performance and impact of ESG investment on sustainability. Based on the two aspects, we firstly suggest that in the literature of ESG disclosure, it would be very important to explore the cost-benefit analysis of the real impact of ESG disclosure for academics as well as policy makers, given the limited and ambiguous evidence published in accounting journals.[8] Secondly, in terms of ESG investing, several questions needed to be answered, such as, to what extend ESG investing influence a structure change in the way investors allocate resources, how well ESG investing can truly achieve sustainability goals in the asset management industry, whether ESG investing really be beneficial for asset managers and their clients.

6 Conclusions

The objective of this research is to present the conceptual and intellectual structure of EF and ESG study in economics and finance. To draw a chronical picture of the past, present, and future research in two research fields, we use a bibliometric analysis method to conduct top author, cited papers, journal analysis, co-authorship analysis, country collaboration analysis, co-citation analysis of both authors and articles, keyword cluster analysis, keyword co-occurrence analysis, topical trends over timeline analysis, and top journal publications analysis on the relevant literature in the Scopus database from 1990 to 2021.

In EF related studies, Taghizadeh-Hesary F. contributes most numbers of publications and Zhang D. is the top single contributed author. Sixteen percent of these articles are published in three journals: “Journal of Cleaner Production”, “Energy Economics”, and “Journal of Sustainable Finance and Investment”. Secondly, the co-authorship analysis finds out that the largest clusters of co-authorship are centred in the US, then the UK and China. Five high concentrated author collaboration groups and two journal clusters have been established. Thirdly, the topic trend analysis describes that climate change, green finance, and sustainability are the hottest topics.

In ESG related research, Li Y. contributes most numbers of publications and Buallay A. is

[8] For example, Drempetic et al (2020), Whelan et al. (2021), and Krueger et al (2021).

the top single contributed author. Fifteen percent of articles are published in three journals: "Journal of Cleaner Production", "Marine Policy", and "Ecological Economics". Secondly, the co-authorship analysis finds out that the largest clusters of co-authorship are centred in the US and Italy. The four high concentrated author groups and two journal clusters have been established, although the collaboration network has been quite scattered. Thirdly, the topic trend analysis describes that apart from ESG key words, financial performance and sustainability are also the hottest topics in the ESG study.

Between 1990 to 2022, there are 38 EF papers and 25 ESG papers published in the top journals. Most of them are published in organization and management journals, only 6 EF papers and 4 ESG papers are published in Economics and Finance journals.

The bibliometric analysis does not only visualize the history of research trend and current interested topics, but also help us to identify future research. We summarize three main research directions in EF study, including global effort to establish environmental regulation framework for ecological challenges, developing financial innovation in green sectors, and managing risks associated with environmental financialization. Several questions are needed to be addressed in future research of ESG investing, for example, to what extend ESG investing influence a structure change in the way investors allocate resources; how well ESG investing can truly achieve sustainability goals in the asset management industry, whether ESG investing really be beneficial for asset managers and their clients. The future research programme in the literature of ESG disclosure needs to explore the cost-benefit analysis of the real impact of ESG disclosure.

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Zhao, H., Zhang, F., & Kwon, J. (2018). Corporate social responsibility research in international business journals: An author co-citation analysis. *International Business Review, 27*, 389–400. doi:https://doi.org/10.1016/j.ibusrev.2017.09.006

TABLES

Table 1: Search strategy

Area of study	Search strategy
EF	(TITLE-ABS-KEY (**environmental** AND **finance**) OR TITLE-ABS-KEY (**climate** AND **finance**) OR TITLE-ABS-KEY (**green** AND **finance**) OR TITLE-ABS-KEY (**carbon** AND **finance**)) AND PUBYEAR > **1989** AND PUBYEAR < **2023** AND (LIMIT-TO (PUBSTAGE, "**final**")) AND (LIMIT-TO (DOCTYPE, "**ar**")) AND (LIMIT-TO (SUBJAREA, "**BUSI**") OR LIMIT-TO (SUBJAREA , "**ECON**")) AND (LIMIT-TO (SRCTYPE, "**j**"))
ESG	(TITLE-ABS-KEY (**environmental** AND **social** AND **governance**) OR TITLE-ABS-KEY (**esg**)) AND PUBYEAR > **1989** AND PUBYEAR < **2023** AND (LIMIT-TO (PUBSTAGE, "**final**")) AND (LIMIT-TO (DOCTYPE, "**ar**")) AND (LIMIT-TO (SUBJAREA, "**BUSI**") OR LIMIT-TO (SUBJAREA, "ECON")) **2022** AND (LIMIT-TO (SRCTYPE, "**j**"))

Table 2: Descriptive Statistic

Measure	EF Count	ESG Count
Documents	2114	2734
Timespan	1990:2022	1990:2022
Sources (Journals, Books, etc)	693	727
Average citations per documents	24.73	22.4
Average citations per year per doc	3.647	3.656
Author's Keywords	5669	6666
Keywords Plus	5231	4164
Authors	4745	6269
Author Appearances	5502	7468
Authors of single-authored documents	481	571
Documents per Author	0.446	0.436
Co-Authors per Documents	2.6	2.73

Note: The above table presents the key characteristics of sample of analysed research articles.

Table 3: Top 10 Authors

EF				ESG			
Authors	Articles	Authors	Articles Fractionalized	Authors	Articles	Authors	Articles Fractionalized
Taghizadeh-hesary F.	14	Zhang D.	4.92	Li Y.	12	Buallay A.	5.92
Wang Y.	10	Taghizadeh-hesary F.	4.18	Buallay A.	10	Camilleri M.A	5.00
Wang Z.	10	Lee C.C.	3.25	Crifo P.	9	Velte P..	5.00
Lee C.C.	9	Yoshino N.	3.00	Gallefo-Alvarezi I.	8	Giannarakis G.	4.17
Li Y.	9	Zhang H.	2.95	Rezaee Z.	8	Galbreath J.	4
Wang X.	9	Wang Z.	2.80	Wang J.	8	Paavola J.	4
Moneva J.M.	8	Monasterolo I.	2.75	Wang Z.	8	Rezaee Z.	3.78
Yoshino N.	8	Wang X.	2.75	Zhang X.	8	Crifo P.	3.53
Zhang D.	8	Wang Y.	2.71	Zhang Y.	8	Jitmaneeroj B.	3.53
Zhang H.	5	Bergset L.	2.50	Gangi F.	7	Li Y.	3.37

Note: The above table illustrates the top authors in terms of outputs and contribution adjust for co-authorship.

Table 4: Top 10 output journals

Sources	EF-Articles
Journal of Cleaner Production	227
Energy Economics	65
Business Strategy and The Environment	54
Journal of Sustainable Finance and Investment	52
Ecological Economics	49
Resources Policy	39
Environmental and Resource Economics	37
Technological Forecasting and Social Change	30
World Development	29
Journal of Environmental Economics and Management	26
Sources	**ESG-Articles**
Journal of Cleaner Production	171
Marine Policy	118
Business Strategy and The Environment	77
Ecological Economics	70
Journal of Business Ethics	69
Corporate Social Responsibility and Environmental Management	61
Journal of Sustainable Finance and Investment	54
World Development	46
Sustainability Accounting Management and Policy Journal	42
Forest Policy and Economics	39

Note: The above table illustrates the top 10 Journal publication sources.

Table 5: Author Countries

Country	EF-Articles	Country	ESG-Articles
US	283	US	255
China	241	United Kingdom	213
United Kingdom	151	China	155
Australia	73	Australia	152
Germany	71	Italy	119
Italy	62	Spain	93
Spain	61	Canada	92
France	51	Germany	84
Canada	50	France	81
India	40	Netherlands	67

Note: The above table illustrates the countries in the author locations.

Table 6: Top 10 citation countries

Country	EF Total Citations	Average Article Citations	Country	ESG Total Citations	Average Article Citations
US	10793	38.14	US	10005	39.24
China	4768	19.78	United Kingdom	8029	37.69
United Kingdom	4550	30.13	Australia	4235	27.86
Spain	2691	44.11	Germany	3094	36.83
Australia	2304	31.56	Spain	2993	32.18
Canada	1757	35.14	Netherland	2567	39.31
Netherland	1579	39.48	Canada	2414	26.24
France	1278	25.06	China	2155	13.90
Germany	1134	15.97	Italy	2076	17.45
Turkey	1011	67.4	France	1264	15.60

Note: The above table illustrates the top ten citations count in countries.

Table 7: Top 10 Cited papers

EF-Paper	Year	Journal	Total Citation	Total Citation/Year
Klassen & McLaughlin	(1996)	Manage SCI	1540	57.0
Cheng et al.	(2014)	Strategic Manage J	1097	121.9
Terjesen et al.	(2009)	Corp Gov	707	50.5
Ozturk & Acaravci	(2013)	Energy Econ	701	70.1
Renneboog et al.	(2008)	J Bank Finance	694	46.3
Barnett M.L.	(2006)	Strategic Manage J	667	39.2
Jalil & Feridun	(2011)	Energy Econ	614	51.2
Gray R.	(2010)	Account Organ Soc	593	45.6
Tamazia & Bhaskara.	(2010)	Energy Econ	522	40.2
Hallikas et al.	(2004)	Int J Prod Econ	498	26.2
ESG-Paper				
Cheng et al.	(2014)	Strategic Manage J	1097	121.9
Terjesen et al.	(2009)	Corp Gov	707	50.5
Renneboog et al.	(2008)	J Bank Financ	694	46.3
Jo & Harjoto	(2011)	J Bus Ethics	597	49.8
Friede G.	(2015)	J Sustain Finance Invest	487	60.9
Walls et al.	(2012)	Strategic Manage J	464	42.2
Post et al.	(2011)	Bus Soc	445	37.1
Foley et al.	(2010)	Mar Policy	375	28.8
Kolk & Perego	(2010)	Bus Strategy Environ	363	27.9
Paavola & Adger	(2006)	Ecol Econ	361	21.2

Note: The above table presents the top cited journal articles in the research sample.

Table 8: Country members of co-authorship clusters

Country	EF Cluster	Country	EF Cluster	Country	ESG Cluster	Country	ESG Cluster	Country	ESG Cluster
China	1	Canada	3	US	1	Lebanon	1	Slovakia	2
Pakistan	1	Malaysia	3	United Kingdom	1	Bangladesh	1	Estonia	2
Turkey	1	Japan	3	China	1	Saudi Arabia	1	Croatia	2
Ukraine	1	Hong Kong	3	Australia	1	Kenya	1	Cyprus	2
Nigeria	1	Greece	3	Canada	1	Argentina	1	Malta	2
Poland	1	Ghana	3	Brazil	1	Morocco	1	Cameroon	2
New Zealand	1	Romania	3	Netherlands	1	Fiji	1	Paraguay	2
Ireland	1	Iran	3	Malaysia	1	Kazakhstan	1	Slovenia	2
Serbia	1	Saudi Arabia	3	India	1	Mauritius	1		
Bangladesh	1	Singapore	3	Sweden	1	Tanzania	1		
Bahrain	1	Thailand	3	South Africa	1	Bulgaria	1		
Croatia	1	Lithuania	3	Switzerland	1	Luxembourg	1		
Oman	1	Mexico	3	Indonesia	1	Kuwait	1		
USA	2	Ecuador	3	New Zealand	1	Ecuador	1		
Australia	2	Qatar	3	Japan	1	Oman	1		
Italy	2	Cyprus	3	Ukraine	1	Iraq	1		
Netherlands	2	Slovenia	3	Finland	1	Nepal	1		
Sweden	2	Spain	4	Korea	1	Iceland	1		
Belgium	2	France	4	Turkey	1	Italy	2		
Norway	2	Brazil	4	Hong Kong	1	Spain	2		
Austria	2	Indonesia	4	Pakistan	1	Germany	2		
Costa Rica	2	Denmark	4	Colombia	1	France	2		
Czech Republic	2	Egypt	4	Tunisia	1	Portugal	2		
Chile	2	Tunisia	4	Nigeria	1	Norway	2		
Colombia	2	United Kingdom	5	Qatar	1	Romania	2		
Israel	2	South Africa	5	Zimbabwe	1	Poland	2		
Micronesia	2	Switzerland	5	Ethiopia	1	Belgium	2		
Philippines	2	Portugal	5	Thailand	1	Greece	2		
Iceland	2	Finland	5	Iran	1	Denmark	2		
Luxembourg	2	Korea	5	Bahrain	1	Czech Republic	2		
Palau	2	Hungary	5	Mexico	1	Ireland	2		
Guinea	2	Kenya	5	Singapore	1	Hungary	2		
Marshall Islands	2	Argentina	5	Chile	1	Lithuania	2		
Papua New Guinea	2	Ethiopia	5	Egypt	1	Israel	2		
Germany	3	Botswana	5	Austria	1	Serbia	2		
India	3	Zimbabwe	5	Ghana	1	Latvia	2		

Note: The above table presents the country clusters in the research sample.

Table 9: Journal coupling

J-EF	Cluster	J-ESg	Cluster
J Cleaner Prod	1	J Cleaner Prod	1
Bus Strategy Environ	1	Bus Strategy Environ	1
Ecol Econ	1	Ecol Econ	1
Environ Resource Econ	1	J Bus Ethics	1
J Environ Econ Manage	1	Corp Soc Resp and Envir Manage	1
Resources, Conservation and Recycling	1	World Development	1
J Bus Ethics	1	Sustainability Accounting, Manage and Policy J	1
Int J Prod Research	1	Resources Policy	1
Long Range Planning	1	Social Responsibility J	1
Int J Energy Sector Manage	1	Corp Gov	1
Organization And Envir	1	Accounting, Auditing and Accountability J	1
Applied Econ	1	J Applied Accounting Research	1
Econ Modelling	1	J Bus Research	1
Accounting, Auditing and Accountability J	1	Resources, Conservation and Recycling	1
Corp Soc Resp and Envir Manage	1	Business And Society	1
J Manage in Engineering	1	Meditari Accountancy Research	1
Research Policy	1	Corp Gov: An Int Review	1
Technology In Society	1	Management Decision	1
Energy Economics	2	Corp Ownership and Control	1
J Sustainable Finance and Investment	2	Journal Of Global Responsibility	1
Resources Policy	2	Technological Forecasting And Social Change	1
Technological Forecasting and Social Change	2	Corp Gov (Bingley)	1
World Development	2	J Sustainable Tourism	1
Int Environ Agreements: Politics, Law and Econ	2	Energy Econ	1
Envir, Development and Sustainability	2	J Sustainable Finance and Investment	2
Forest Policy and Econ	2	Envir, Development and Sustainability	2
Finance Research Letters	2	Finance Research Letters	2
Frontiers In Energy Research	2	J Portfolio Manage	2
Global Finance J	2	Cities	2
Int J Energy Econ and Policy	2	J Asset Manage	2
Sustainability Accounting, Manage and Policy J	2	J Corp Finance	2
Int J Green Economics	2	J Investing	2
Int Review Financial Analysis	2	Global Finance J	2
Econ Analysis And Policy	2	Research In Intl Bus and Finance	2
Oxford Review Economic Policy	2	Organization And Environment	2
		Int Review Financial Analysis	2
		J Banking And Finance	2
		J Risk Manage in Financial Institutions	2

Note: The above table presents the journal clusters in the research sample.

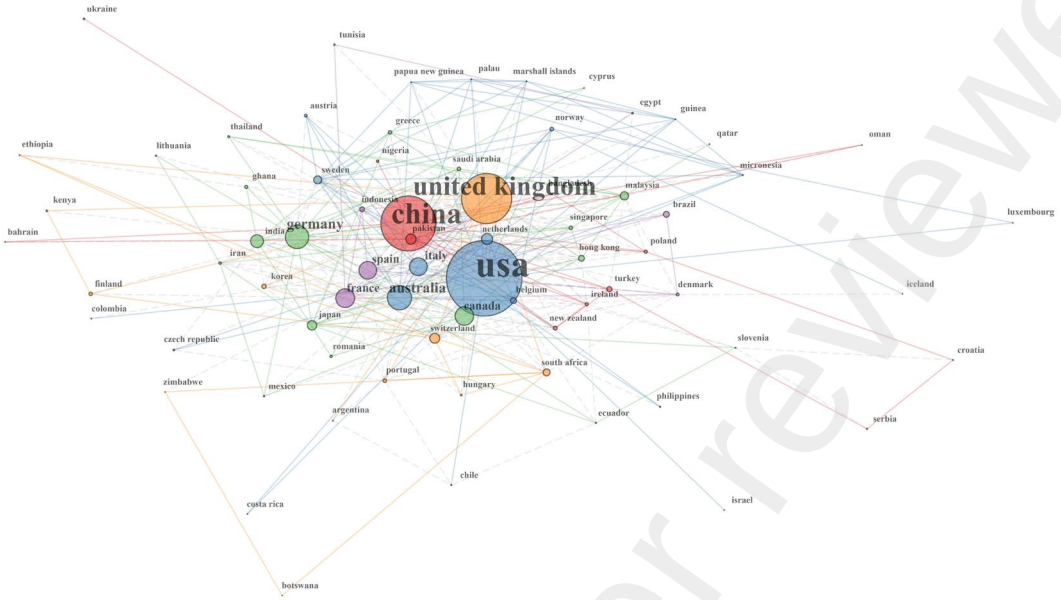
Table 10: Top Journal Publications

EF-J Title	<2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Account									1		
J Account Research					1						
American Eco Review	1										
Econometrica	1										
J Political Economy	1										
J Finance	2	1									
J Financial Ecos	1				1					1	
Review Financial Studies									1		
MIS Quarterly: Manage Information Systems		1									
Research Policy	4								2	1	
J Marketing		1									
J the Academy Marketing Science	1										
J Operations Manage	3							1			
Manage Science	4		1								
Public Administration Review	1										
Strategic Manage J	2		1		1	1					
ESG-J Title	**<2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Account										1	
J Account and Ecos									1		
Review Financial Studies									1	2	
J Int Business Studies										1	
Research Policy	1		1					1	1		
J Operations Manage									1	1	
Manage Science								1	1		
Organization Science			1	1						1	
Public Administration Review	1						1				
Strategic Manage J	2		1			1		2			

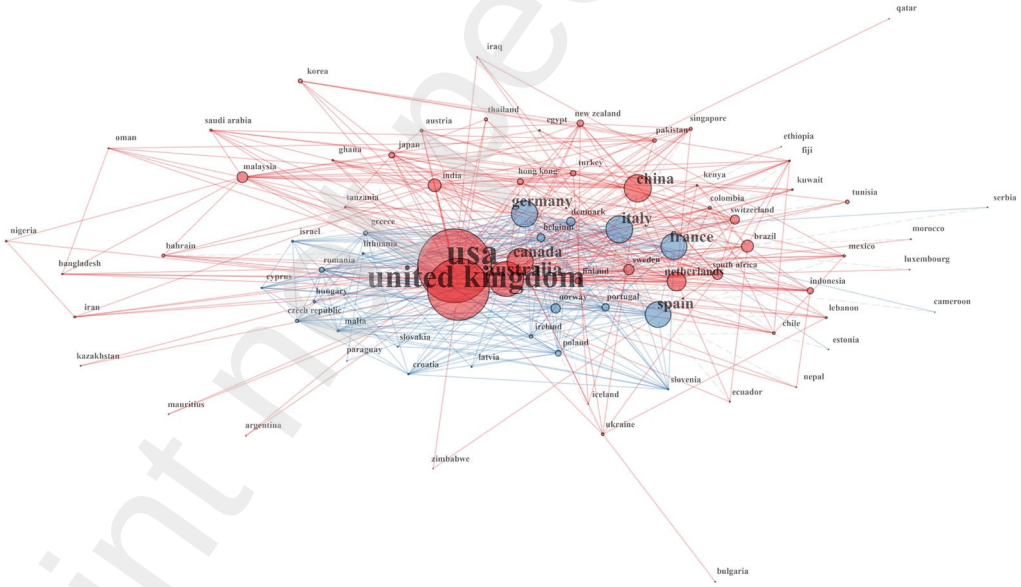
Note: The above table presents the international leading journal publications in the research sample.

FIGURES

Figure 1: Co-authorship Patterns across countries-EF &ESG



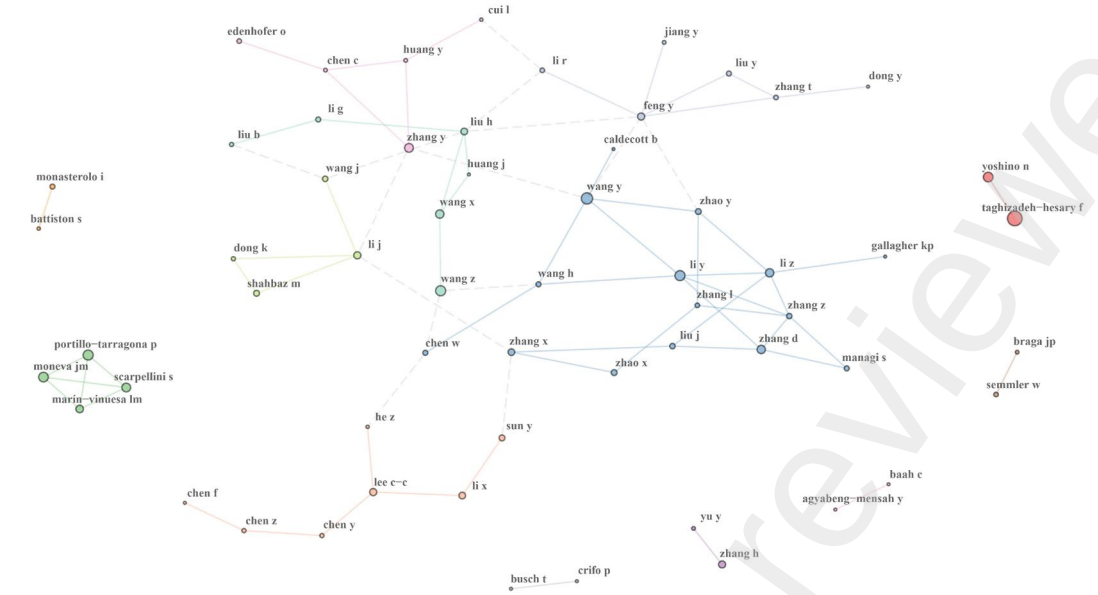
(A) EF country collaboration



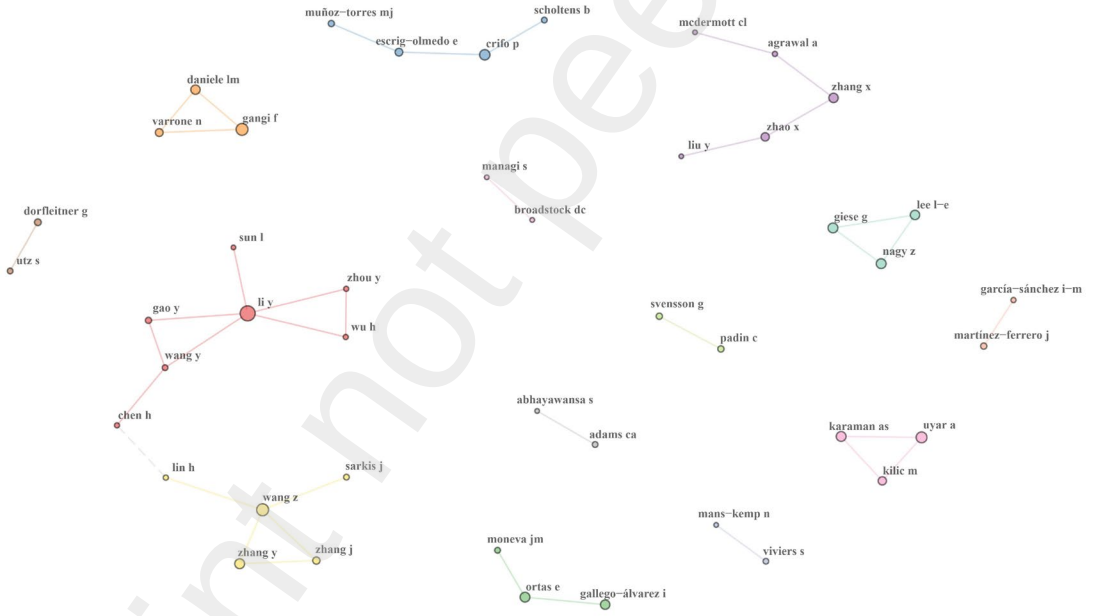
(B) ESG country collaboration

Note: For limiting the amount of visual clutter, we focus on authors who have published 5 or more papers. This figure illustrates the co-authorship pattern across countries.

Figure 2: Co-authorship Patterns across authors



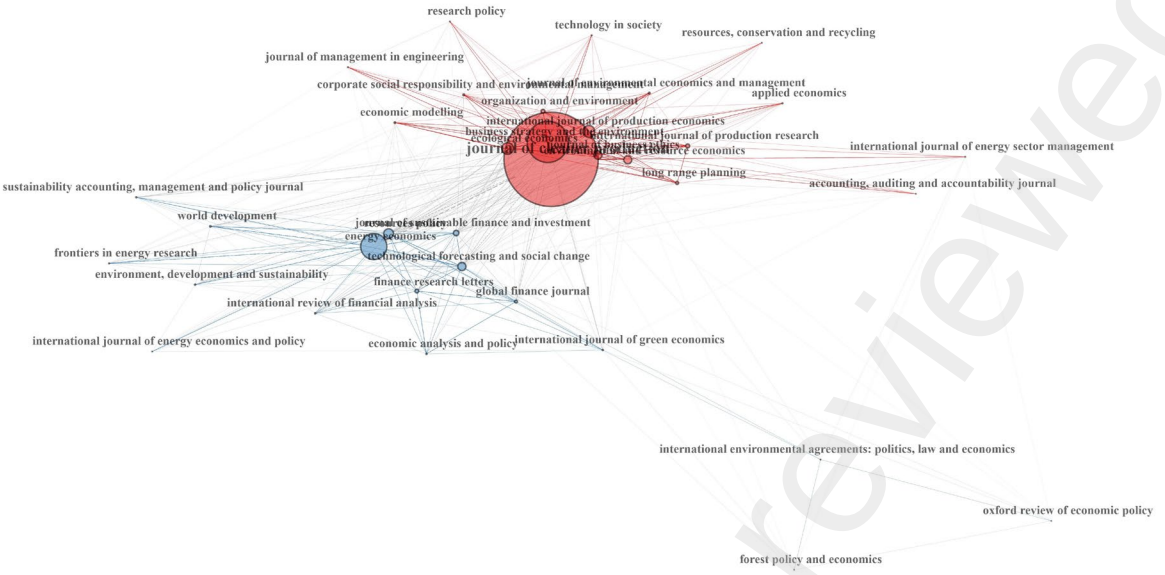
(A) EF author collaboration



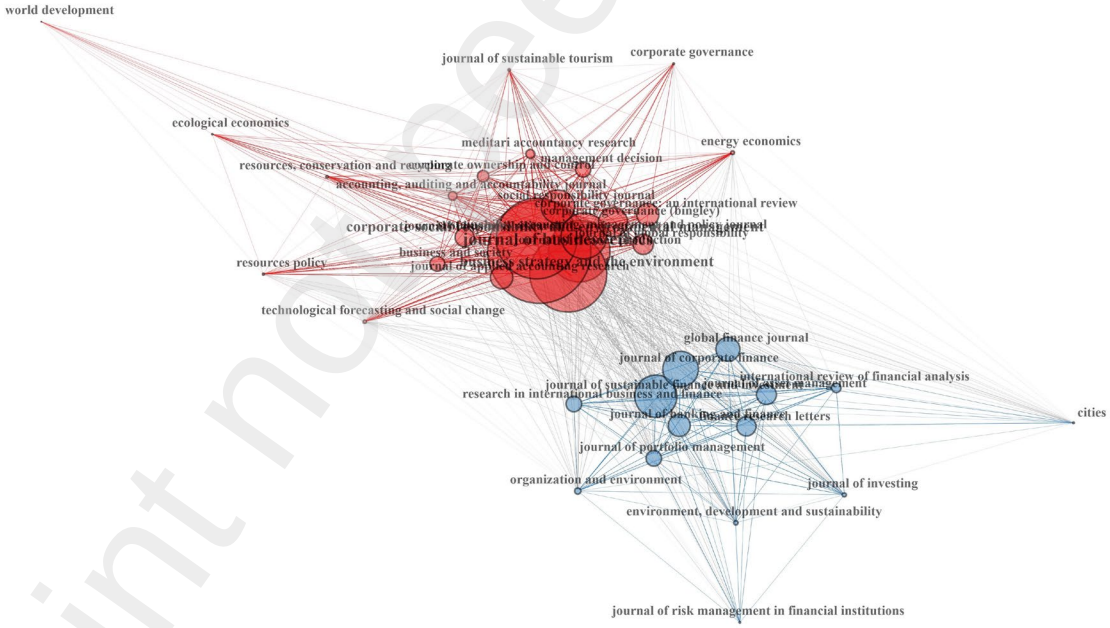
(B) ESG author collaboration

Note: This figure above shows the co-authorship patterns across individual authors, with the threshold set again at the minimum of 4 publications.

Figure 3: Journal coupling



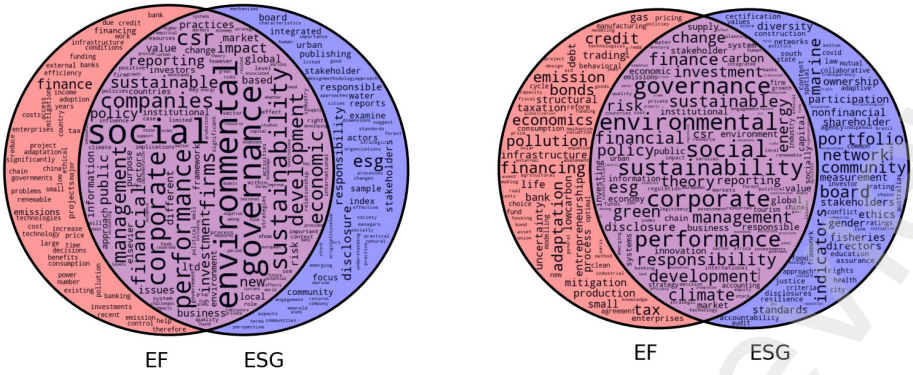
(A) EF journal coupling



(B) ESG journal coupling

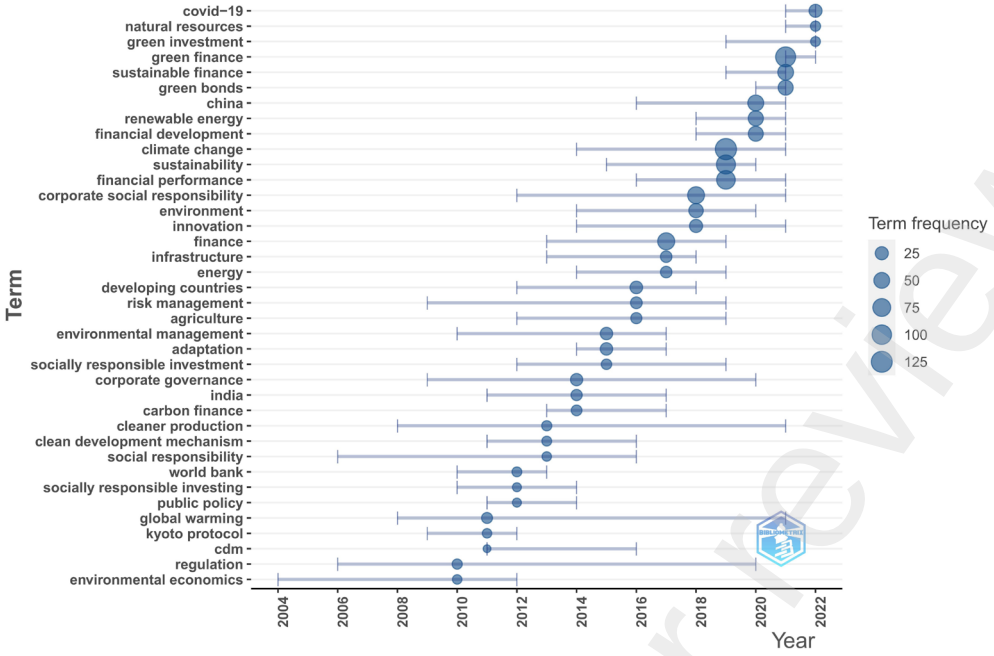
Note: This figure above shows the journal citation cluster patterns. We impose a 6-article citation.

Figure 4: Word clouds Venn diagram-EF & ESG

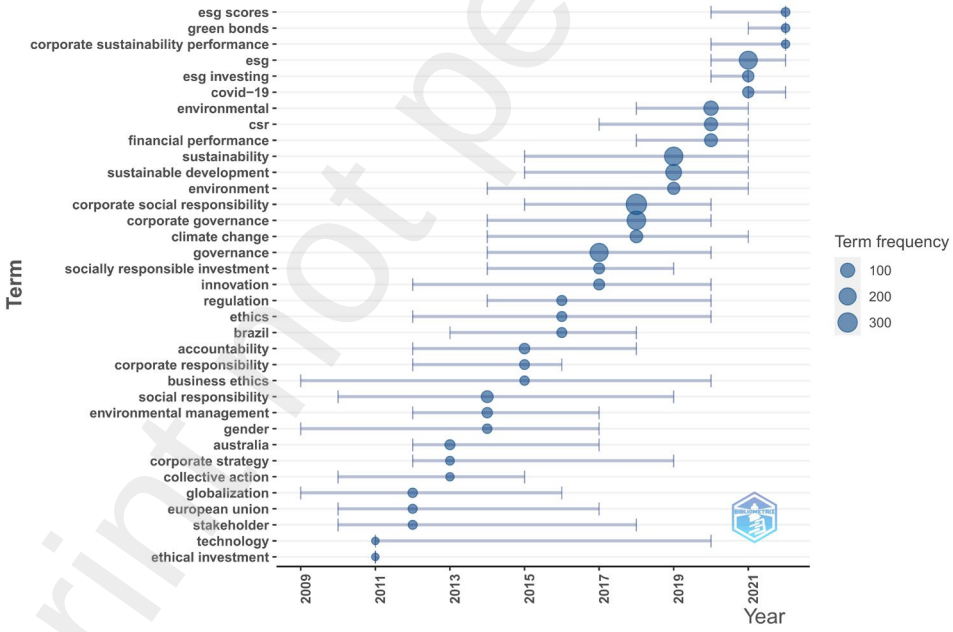


Note: The above wordclouds picture the top 200 key words from the abstracts and keywords of the analysed research articles. For better visualization, we take ESG keyword in logarithm due to its high frequency difference.

Figure 5: Evolution of topics-EF & ESG



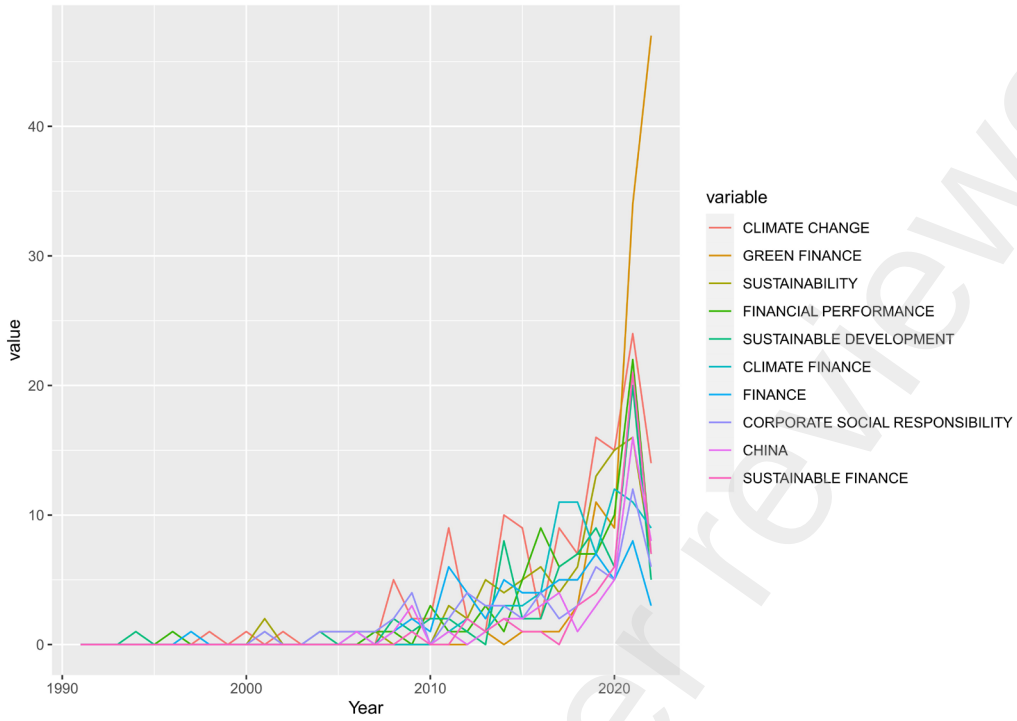
(A) EF trend topics



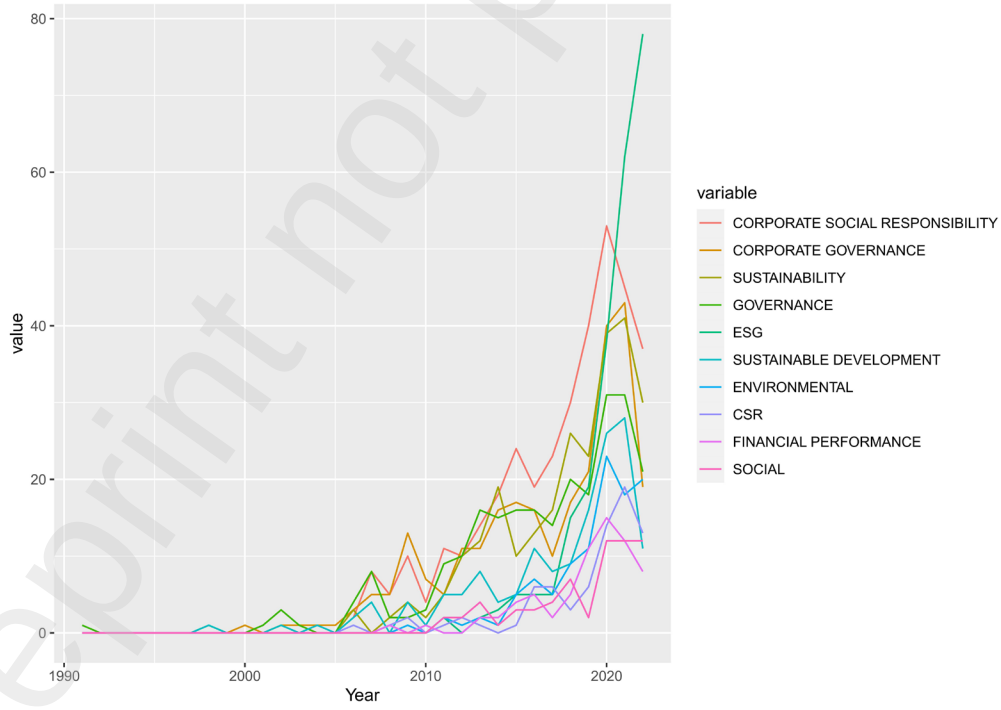
(B) ESG trend topics

Note: This figure above draws the range and median year for each keyword up to 2020.

Figure 6: Occurrence frequency of keywords-EF & ESG



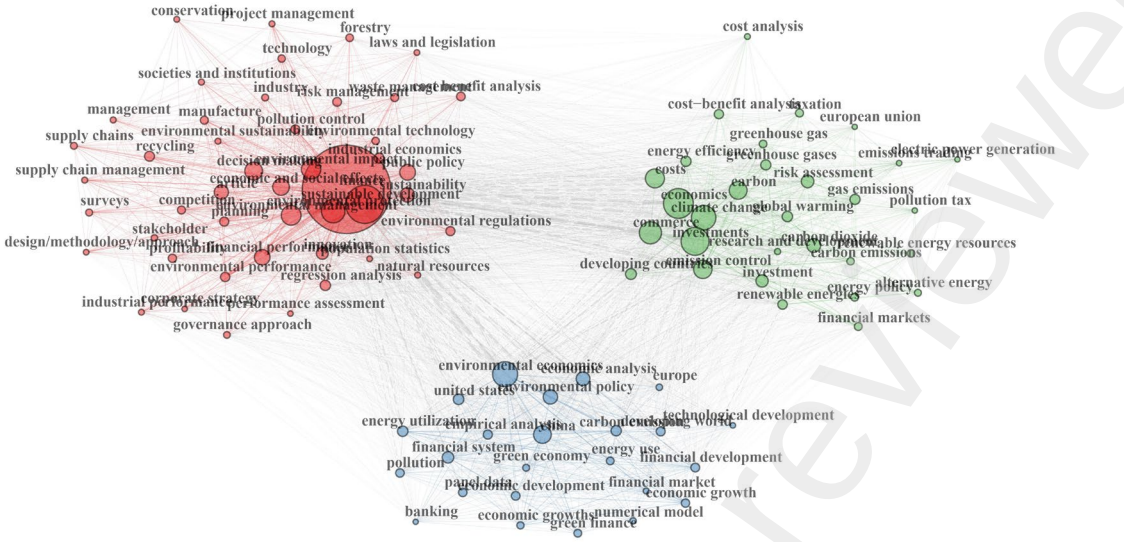
(A) EF keywords frequency occurrence



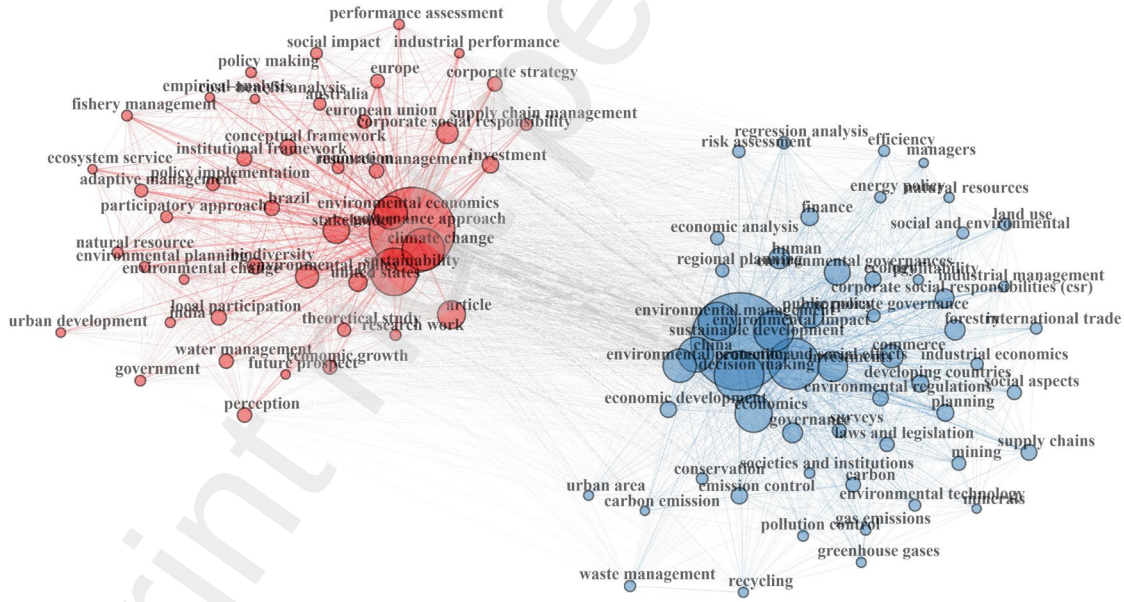
(B) ESG keywords frequency occurence

Note: This figure above draws the frequency of keywords occurrence from 1990 to 2020.

Figure 7: Keyword Co-occurrences



(A) EF keywords co-occurrence



(B) ESG keywords co-occurence

Note: This figure above represents the keyword co-occurrence networks.