Can we trust ESG Ratings?
Some insights based on a bibliometric analysis of ESG data quality and rating reliability

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Abstract

The aim of this research is to investigate the quality and reliability of ESG data provided by companies, as well as the accuracy and objectivity of ESG ratings produced by sustainability rating agencies (SRAs). Since SRAs use companies' non-financial information as input data when formulating their ESG ratings, these two topics appear to be strictly interconnected.
Drawing on the Shanon and Weaver (1949) model of communication, we have addressed these issues by means of a systematic literature review combined with a bibliometric analysis. In our investigation we run: *i*) the co-citation analysis to detect the seminal papers; *ii*) a keyword co-occurrence analysis to explore how the main features of the academic debate have unfolded in the last five years; *iii*) a keyword co-occurrence analysis to obtain a network visualisation map to explore how the research broad scope was articulated in different clusters (i.e., themes of research). Among the clusters that emerged from the mapping, we have decided to delve into the streams of research we consider most relevant and deal with: the relationships between ESG and Artificial Intelligence (AI). Namely, we deem that AI may allow us to process massive amounts of data that contain crucial information for ESG investing. However, even if computer algorithms are able to analyse all information available efficiently, and in a timely manner, managers and investors should be aware of their opportunities and criticisms, while scholars should list propositions for advancing the research on these topics.

Keywords: ESG ratings, Data quality, Theory of communication, Artificial Intelligence, Bibliometric analysis

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1. Introduction

Since most investors have integrated Environmental, Social and Governance (ESG) information into their investment decisions, larger pools of capital are available to the companies that pay greater attention to Environmental, Social and Governance (ESG) issues (Ioannou and Serafeim, 2015; Kotsantonis *et al.*, 2016; Eccles and Klimenko, 2019). The growing awareness that 'sustainable' investments may produce better financial performance (Friede *et al.*, 2015: Alshehhi, 2018), and lower cost of capital (Dhaliwal *et al.* 2011), has indeed prompted numerous companies to voluntarily publish sustainability reports with the aim of guiding, at least in part, investment decisions (Willis, 2003; Magness, 2010; Berthelot *et al.*, 2012; Lourenco *et al.*, 2012; De Villiers, 2017).

With the aim of providing guidance for investors seeking further insight into sustainability performance, many sustainability indices have been designed by rating agencies to measure the performance of the firms that set industry-wide best practices with regard to sustainability (Robinson *et al.*, 2011; Escrig-Olmedo *et al.*, 2019).

Sustainability indices provide meaningful signals of social legitimacy in an attempt "to verify that a firm's goals and actions align with societal values such as environmental sustainability, labour and human rights, anti-corruption practices, and community engagement" (Hawn *et al.*, 2011, p. 3). It has indeed been argued that they serve as informational intermediaries between companies and their stakeholders (such as analysts, brokers and financial institutions but not only) by evaluating the information on ESG issues released by companies through different media and channels (Robinson *et al.*, 2011; Clarkson *et al.*, 2019; Galeotti *et al.*, 2022). Within the realm of sustainability indices, the most widely recognised are the DJSI Family. Established in 1999 and maintained collaboratively by RobecoSAM and S&P Dow Jones Indices, the DJSI family tracks the performance of the world's largest companies leading the field in terms of corporate sustainability (López *et al.*, 2007; Searcy and Elkhawas, 2012; Hawn *et al.*, 2018; Bernardi and Demartini, 2019).

However, the quality of ESG performance provided by the company and how they are translated by rating agencies in sustainability indices does not lack criticism (Durand *et al.*, 2019; Arribas *et al.*, 2021; Avramov *et al.*, 2022; Tsang *et al.* 2023) as explained in the following. For investors, having measurable and trustworthy ESG indices allows them to track companies' performance over time and check, at a future time, if they have been able to achieve the objectives set out in the past. For the management of the company, setting and disclosing information regarding ESG performance is appreciated by the ESG investors, making it easier to define appropriate strategies and policies to reach them. Last but not

least, all stakeholders should be able to objectively evaluate and compare different companies' sustainability performance: this is possible only when using suitable, complete and standardised metrics.

In the past, the assessment for the inclusion in a main index, such as the Down Jones Sustainability launched in 1999, was mainly based on information provided by the companies through questionnaires and interviews complemented with non-financial data acquired through the manual screening of official corporate sources (e.g. websites, corporate reporting, press releases, etc.), as well as through surveys and market analysis. Nowadays a large amount of information on ESG corporate performance is available, can be gathered from several sources inside and outside the company and media channels (i.e., websites, social media, newspapers, etc.), and is also elaborated using Artificial Intelligence (AI).

This brings with it several problems and criticism about the quality and reliability of the information gathered by info-providers and the algorithm applied by rating agencies (Berg *et al.*, 2020; Billio *et al.*, 2021; Sahin *et al.*, 2023).

Companies' ESG data are scattered throughout different sections of different public documents (depending on the specific firm) and can have the form of quantitative or qualitative information (Saad and Strauss, 2020). In both cases, sometimes it is not even clear how companies translate sustainability principles into strategic and operational objectives, and then measure their ESG performance (Wang *et al.*, 2023). Furthermore, there are no guidelines explaining how investors should interpret these results (In *et al.*, 2019; Serafeim and Yoon, 2022). Even though many institutional actors and NGOs are working towards a joint vision, the goal of shaping a comprehensive global framework has not yet been reached (Cruz and Matos, 2023).

Hence, it is necessary to find out how to guarantee and verify the reliability of ESG performance by analysing the quality of the information flow from its origin to the end users.

For this purpose, in our study, we will draw on the communication model elaborated by Shannon and Weaver (1949), who study the process of processing and transmitting information from an issuer to a recipient and focus precisely on the process of coding and decoding information, as a fundamental aspect to guarantee the effectiveness of communication, which we have seen to be the central theme in the above rationale for our research.

Namely, the aim of this paper is to investigate the quality and reliability of ESG data provided by the companies, as well as the accuracy and objectivity of ESG ratings produced by sustainability rating agencies (SRAs). Since SRAs use companies' non-financial information as input data when formulating their ESG ratings, these two topics appear to be strictly interconnected. At the same time,

the implementation of new data processing to collect and process information is emerging as a central theme for assessing the quality of ESG information flow.

Previous studies analyse some of the elements that comprise the quality of ESG information. Yet, they consider these issues in an isolated way, related to specific purposes (i.e., the quality of ESG information for sustainable investing), rather than focusing on the whole communication flow. On the contrary, we deem a holistic analysis of all the involved elements is key to properly understanding the ESG communication process, therefore with the aim to offer a broad picture of the problem outlined up to now, we have addressed these issues by means of a systematic literature review (Transfield *et al.*, 2003) combined with a bibliometric analysis (Donthu *et al.*, 2021), based on the following research questions:

- How has the topic of ESG data quality developed over the last 5 years?
- What is the current state-of-the-art?
- What are the main literature gaps that might guide future research avenues?

The use of VOSviewer software (Van Eck and Waltman, 2010) enabled us to run a bibliometric analysis to investigate the conceptual structure of the field under examination (Ji *et al.*, 2018) and to address possible future research avenues regarding:

i. the quality and reliability of ESG data and ratings,
ii. the implementation of new data processing technologies – such as Distributed Ledger Technologies (DLTs) and Artificial Intelligence (AI) – in the mechanisms of ESG disclosure and rating formulation.

Namely, we deem that AI may allow us to process massive amounts of data that contain crucial information for ESG investing. However, even if computer algorithms are able to analyse all information available efficiently and in a timely manner, managers and investors should be aware of their opportunities and criticisms, while scholars should list propositions for advancing the research on these topics.

This paper is structured as follows. Section 2 illustrates the theoretical background and the purpose of the research, while Section 3 focuses on the methodology applied. An overview of the bibliometric results is presented in Section 4. Section 5 draws on the findings and provides an interpretation of the state-of-the-art on ESG data quality research, while 6 highlights some implications for future research directions. Conclusions follow in section 7.

2. Theoretical background and purpose of study

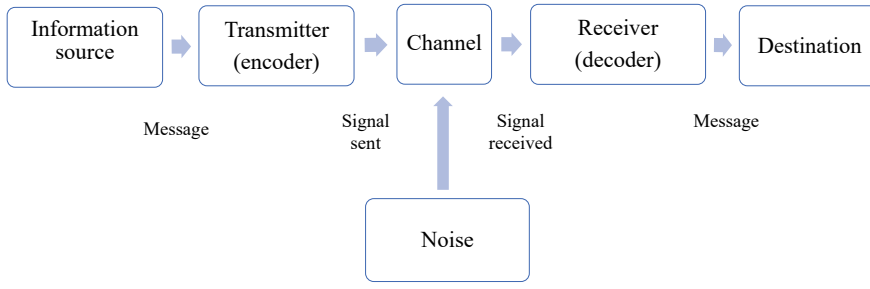
To thoroughly examine our research topic, we refer to the well-known theoretical framework of information theory that takes its starting point from the

mathematical theory of communication by Shannon and Weaver (1949), who have been very influential in various fields (Krippendorff, 2009), including information theory (Cornelius, 2002), communication theory (Fiske, 2011), even CSR communication (Garcia-Torea *et al.*, 2020).

Information theory focuses on the study of data transmission and its processing and measurement of information and consists of a series of elements and processes arranged, in fact, in a linear order, (see Figure 1):

- an information source (Issuer) that encodes a message, which passes through
- a channel or medium of transmission of the signal that is received by
- a recipient (decoder) who decrypts it,
- the factors that can distort or prevent a message from effectively reaching the recipient.

Figure 1 - Shannon and Weaver's model of communication



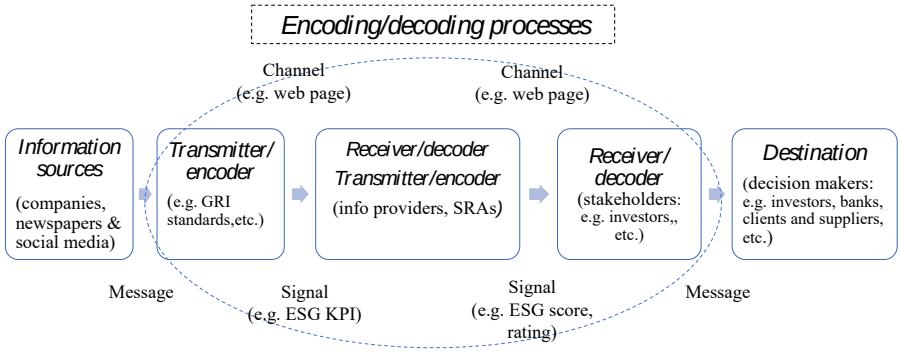
The model elaborated by Shannon-Weaver is also known as the code model, as it maintains that a necessary condition for communicating effectively is to have a shared code to encode and decode signals (Al-Fedaghi, 2012).

Many subsequent theorists built their own models on its insights (Hollnagel and Woods, 2005; Krippendorff, 2009; Fiske, 2011). However, it is often criticised based on the claim that it oversimplifies communication especially to analyse social processes and human communication (Chandler, 1994). One common objection is that communication should not be understood as a one-way process but as a dynamic interaction of messages going back and forth between both participants (Schram, 1954). This approach highlights the dynamic nature of the communication process that unfolds as a multi-directional exchange of messages.

Another criticism argues instead that the message does not exist as a form of preexisting information; this means that coding and encoding processes are creative processes that create the content (Richards, 1955).

Despite criticism and reinterpretation in various disciplinary fields, the model is still recognised as influential today. As accounting scholars, we are very interested in investigating the coding and decoding processes of ESG information, which represent a starting point for assessing the quality of the information system. Hence, we have built on Shannon and Weaver's model to draw a framework for the ESG information as a communication system (see Figure 2)

Figure 2- ESG communication system



As source of information, we consider not only the firms but also other external sources of ESG information (i.e., social media and newspapers). The firm and other external sources decide on which messages will be communicated.

Companies select the message they want to communicate depending on their motivation for disclosing ESG information (e.g., accountability, green-washing, legitimisation and mandatory requirements) (Krueger *et al.* 2021). Companies can collect information internally and externally, for example, by interacting with supply chain suppliers and stakeholders. The use of AI by companies is increasingly frequent, especially large ones, to collect and process information (Galeotti *et al.*, 2022). ESG information will be collected, processed and encoded on the basis of specific reporting models and standards (i.e., GRI guidelines; TFCD guidance, etc.), which in our model represent the transmitter or encoder element. The outcome is that ESG data is scattered, generally voluntarily, throughout different sections of official reporting (i.e., sustainability or integrated, etc.) and other forms of disclosure (i.e., price-sensitive information, press releases) (Saad and Strauss, 2020). Afterward, firms distribute their reports to their stakeholders

through a channel (i.e., physical reports, document format files, or interactive webpage) (Arvidsson and Dumay, 2022).

Information on companies' ESG available on social media and in newspapers is even more important as they complement, confirm or contradict the ESG data provided by companies. The content of the message comes from journalists, interest groups, activists, researchers, etc., increasingly interested in environmental and social issues. This information is usually presented in written form and conveyed via the internet (Aouadi and Marsat, 2018; She and Michelon, 2019).

In this communication process, the first receivers of the signal are the so-called ESG info provider and/or the SRAs that collect different data points to assess a firm's ESG performance and thus provide an ESG score/rating. In this decoding and coding process, several criticisms arise about the transparency and reliability of algorithms applied by info providers/SRAs (Berg *et al.*, 2020; Billio *et al.*, 2021; Sahin *et al.*, 2023).

The final recipients of the message are the different categories of stakeholders (i.e., investors, asset management companies, banks, clients and suppliers, the public administration and civil society) using ESG scores and ratings in their decision-making. They decode the message and interpret the information. Each firm's stakeholders may consider different impacts as relevant, hence, decoding the signal on the basis of their priorities and ESG framework (Amel-Zadeh and Serafeim, 2018; In *et al.*, 2019; Serafeim and Yoon, 2022).

What emerges from this picture of the ESG information system is the lack, to date, of a shared code among the various players, throughout the process of production, processing and interpretation of ESG information. Previous studies have analysed some of the elements that comprise the quality and reliability of ESG information. Yet, they consider these issues in an isolated way, related to specific phases (i.e., the drawing of the sustainability reporting) or purposes (i.e., the quality of ESG information for sustainable investing), rather than the whole communication flow. A holistic analysis of all the involved elements is key to properly understanding the ESG communication process.

To draw a complete picture of the ESG information flow, and to detect the scholarly knowledge in this field and the research gaps, the methodology to follow is a systematic literature review (Dumay *et al.*, 2016; Massaro *et al.*, 2016). The latter is a literature review, that attempts to identify, select, synthesise and appraise academic contributions that, in our case, are relevant to answer the above-mentioned RQs.

While since 2020 the number of literature reviews on ESG matters in Accounting, Finance and Management research has dramatically increased, which

means that the topic is gaining momentum and is core to address emerging issues in many fields, from our preliminary scrutiny and search on bibliographic citation databases, we found that none of them is oriented to address our RQs, as can be seen in the summary provided in Appendix (see www.sidrea.it/trust-esg-ratings).

3. Research methodology: a systematic review and a bibliometric analysis

3.1. A systematic review procedure

According to Pickering and Byrne (2014, p. 539), a systematic review method "works well for emerging areas", which is perfectly suited to the topic we want to address, i.e., the quality of ESG data, given its increasing relevance and the possibility of analysing it from different perspectives. The aim is to offer a framework to explore, discover and develop knowledge processes related to an emerging, complex and articulated topic. In so doing, we adopt organised, transparent and replicable procedures (Petticrew and Roberts, 2008). Namely, we have followed the three stages outlined by Tranfield *et al.* (2003): planning, conducting and reporting the review.

The first step, planning, requires the involvement of a review panel, in our case composed of the two authors, to define the key steps to conduct the review and ensure the methodological rigour through a cross-checking process. Planning the review allows us to define the criteria for the search strategy and to outline the research boundaries (Tranfield *et al.*, 2003, p. 215).

The second step consists in conducting the review. Academic contributions have been drawn from Thomson Reuters' Web of Science (WoS), which is one of the most important global bibliographic citation databases of peer-reviewed literature. WoS was chosen because its database consists of over 33,000 sources and focuses on hard science and social science areas, which fit perfectly with the purpose of our research, aiming to contaminate our field of research with insights from authors not only from the social sciences (e.g., accounting, finance, management) but also from other disciplines (e.g., information science).

Based on the main topics we decided to investigate, in November 2022, a search was conducted with the following keywords (included in the title, abstract, author keywords and Keywords Plus): "ESG" or "non-financial information" or "sustainability reporting" AND "rating" or "KPI" or "quality of data" or "artificial intelligence" or "machine learning" or "big data". We have carefully selected all these keywords, through an iterative process of adding new keywords, in order to include many contributions in our dataset and not risk losing some themes that we were not able to identify a priori.

We restricted the examination to English-language texts only from 2013 to 2022 regarding Business Finance, Management, Business and Economics fields.

The result is a set of 125 documents, cited 1,552 times (without self-citations) in the considered timeframe, with 13.17 average citations per item and a Hirsch index[1] of 20.

Subsequently, we built a bibliographic database with all the details of the articles included in the literature review (title, authors, journal and other publication details), and each article was downloaded, collected and stored.

For each documentary source, the content of the abstract was examined individually by each author and the same authors unanimously considered this document to be coherent for the purposes of the research.

The third and last step concerns the reporting of the review. According to Tranfield *et al.* (2003, p. 218), a two-stage report should be developed: the descriptive and the thematic analyses. The first one allows researchers to provide a description of how research has developed and to understand which authors are contributing the most and how. The second stage allows them to identify key emerging themes. In this stage, linking the themes across the main contributions and identifying research gaps for future investigation are crucial in the reporting process.

In terms of methodology, the novelty of our study is the combination of a systematic literature review with a bibliometric analysis, which allows us, through specific software and techniques, to uncover clusters of interconnected themes characterising the structure of the research field.

A systematic literature review uses systematic procedures, which are typically carried out manually by scholars. It requires a narrow scope of study and thus tends to include a lesser number of papers for review (e.g., between tens and low hundreds) (Snyder, 2019). In that sense, systematic literature reviews are better suited for niche research areas. In our case, the number of papers extracted, 125, is quite high, but above all, the use of bibliometric analysis is justified because the research scope is broad and has no limited boundaries. Therefore, as we will explain below, we adopted a bibliometric analysis to map the main topics and how they are interrelated.

[1] It is a distribution-based indicator reflecting the number of papers (N) in a given dataset having N or more citations. In our case, a Hirsch index of 20 indicates that 20 papers in the given set were cited at least 20 times each. This measure attempts to reflect both productivity (number of papers) and impact (number of citations) in one number.

3.2. A bibliometric analysis procedure

Unlike systematic literature reviews that tend to rely on qualitative techniques, bibliometric analysis relies upon quantitative techniques. The bibliometric analysis is a scientific method that can be useful for scholars who wish to pursue a retrospective of broad and rich areas in business research (Donthu *et al.*, 2021). Bibliometric methodology has gained immense popularity recently due to the usefulness of bibliometric software (such as VOSviewer) and databases (i.e., WoS or Scopus) that ease the acquisition and assessment of large volumes of scientific data.

The aims of a bibliometric study are to unveil the so-called 'performance' and 'intellectual capital' of a research field. In terms of performance, bibliometric analysis may help to gather information on the research constituents (which may include authors, institutions, countries and journals).

In terms of intellectual capital, bibliometric analyses "*reveal the bibliometric structure that encapsulates the networks between research constituents contributing to the intellectual structure that is founded upon clusters of interconnected themes in the research field*" (Donthu *et al.*, 2021, p. 287).

To this aim, we made use of VOSviewer software (Van Eck and Waltman, 2010), which maps and clusters bibliometric networks based on citation, co-citation, co-authorship, co-occurrence and bibliographic coupling links[2] .

Each link has a *strength* which is represented by a positive numerical value: the higher this value, the stronger the link. For example, in the case of co-occurrence links, the strength indicates the number of documents in which two keywords occur together.

Each item of a network has a different size, depending on its prominence within the system. For example, in the case of the co-occurrence network, each keyword has a different size, depending on how many times it occurs throughout the selected documents.

The items of a network may be grouped into clusters that are labelled using numbers and different colours. An advantage of VOSviewer is that it pays special attention to the graphical representation of bibliometric maps in an easy-to-interpret way. Scholars should use bibliometric visualisation to curate analytical over descriptive discussions.

[2] Links are defined as follows:
- citation links: links between pairs of items, one citing the other;
- co-citation links: links between pairs of items, both cited by the same document;
- co-occurrence links: links between pairs of keywords, both occurring together in a considered pair of documents (more specifically, in their titles, abstracts or lists of authors' keywords);
- bibliographic coupling links: links between pairs of items, both citing the same document.

In our investigation, we have run:

- the co-citation analysis in order to detect the main studies the topic we are investigating is based on (i.e., seminal papers);
- a keyword co-occurrence analysis was performed using VOSviewer to explore how the main features of the academic debate have unfolded in the last five years (i.e., 2018-2022 chronological development of the topic);
- a keyword co-occurrence analysis was also performed to obtain a network visualisation map to explore how the research's broad scope was articulated in different clusters (i.e., themes of research).

In interpreting the findings from bibliometric analysis, it is important to understand the content of each thematic cluster and the meaning entailed in the topics of publications in that cluster. In order to grasp a good understanding of the content, it is also important to examine their contextual meaning. For example, scholars can rely on the words that manifest prominently in the cluster to understand its content (e.g., words that are more connected than others); however, they must also review how the words are connected to each other in order to decipher the context of each cluster (e.g., studies in which those words appear).

Finally, among the clusters emerging from the mapping, we decided to delve into the streams of research we considered most relevant and dealing with:

- the issues of ESG data and ratings quality, objectivity, reliability and rigorousness;
- the relationships between ESG and Artificial Intelligence.

Moreover, in line with the systematic review, we proceeded to read through all contributions to highlight gaps in the literature and outline future research avenues.

4. Results

4.1. The data set overview

Our data set was made of 125 documents. The topic under examination has experienced rapid growth in recent years, with the greatest number of publications (28) recorded in 2021 (figure 3). Also, the number of citations of the selected publications have seen an exponential growth over time, reaching a peak of 569 in 2021. Such evidence further confirms that the topic we are investigating represents a new research frontier.

Figure 3 - Times cited and publications over time

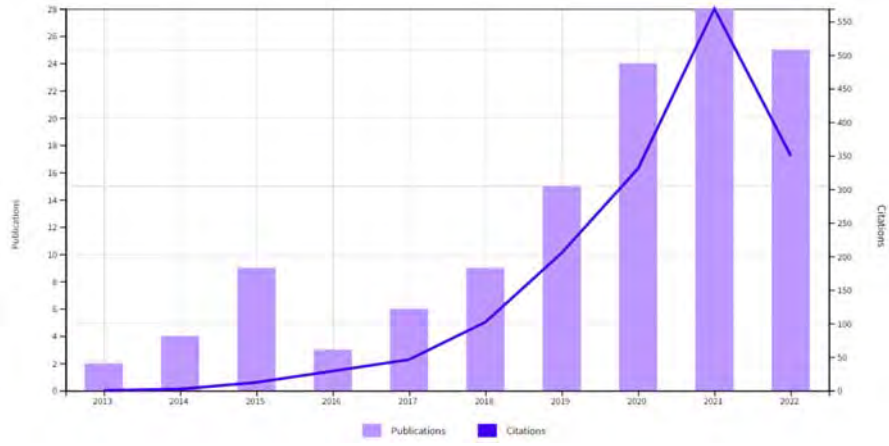


Table 1 shows the sources where at least two items of our sample have been published. The ones with a higher number of publications with respect to the documents selected are: the Journal of Sustainable Finance and Investment (13), Business Strategy and the Environment (8), the Journal of Business Ethics (6), Corporate Social Responsibility and Environmental Management (6), and the Journal of Asset Management (6). They are also the sources that have been cited the most, on average. This shows, as we would have expected, that the main contributions to the topic we are exploring come from documents that have been published in Finance, Business and Management journals. In particular, great attention has to be paid to the sources dealing with sustainability and environmental and social issues.

Table 1 – Sources with a minimum of two items

Source	Documents	Citations
Journal of Sustainable Finance & Investment	13	64
Business Strategy and the Environment	8	205
Journal of Business Ethics	6	430
Corporate Social Responsibility and Environmental Management	6	190
Journal of Asset Management	6	177
Journal of Portfolio Management	5	28
Social Responsibility Journal	4	58
Meditary Accountancy Research	3	26
Finance Research Letters	3	2

Journal of Banking & Finance	2	89
Management Decision	2	76
Financial Analysts Journal	2	18
International Journal of Strategic Property Management	2	15
Journal of the Operational Research Society	2	13
Accounting Auditing & Accountability Journal	2	12
Journal of Applied Corporate Finance	2	7

Source: Web of Science

The selected 125 documents were written by 332 authors. Only 16 of them have published at least two of the items considered, while four of them have been cited more than 50 times.

In particular, the four authors that contributed the most (both in terms of number of papers and quotations) to the development of the topic we are analyzing are: Dorfleintner G., (main research interests: sustainable finance, FinTech, and risk measures); Klein C. (behavioural finance, sustainable and responsible investing); Zwergel B. (behavioural finance, sustainable and responsible investing), and Halbritter G. (sustainable investments and corporate performance evaluation). This bibliometric evidence shows that the debate has developed mainly within the academic community dealing with sustainable finance and responsible investing. The latter involves taking ESG impacts into account when making investment decisions, leading to more long-term investments in sustainable businesses and projects. In this area of research, the quality of information is functional for the smooth functioning of the capital market according to the *efficient-market hypothesis* (Demartini, 2004).

4.2. Development of the research field

A valuable analysis that researchers may conduct using VOSviewer is the co-citation analysis in order to detect the main seminal papers the topic we are investigating is based on.

Then, a complementary keyword co-occurrence analysis was performed to explore how the main features of the academic debate have unfolded in the last years (2018-2022).

The results are discussed in the appendix (www.sidrea.it/trust-esg-ratings).

5. The state-of-the-art on ESG quality of data and rating reliability

An analysis of the development of the research over time shows that, despite the existence of a "fil rouge" between topics, it is evident that our dataset includes academic contributions from multidisciplinary fields of study, mainly: finance, accounting and information systems. Thus, a keyword co-occurrence analysis was performed using VOSviewer to highlight the main themes representing the intellectual structure of our research topic. In our case, the map shows eight main clusters that have been mapped in the light of our interpretative framework (see the results in appendix, www.sidrea.it/trust-esg-ratings).

Among the clusters that have emerged from the mapping, we have decided to delve into the research streams that we consider to be closest to the encoding and decoding processes of ESG information. These relate to:

- the quality, objectivity, reliability, and rigorousness of ESG data and ratings (clusters 1 and 2);
- the connections between ESG information and Artificial Intelligence (cluster 3).

Moreover, in line with the systematic review, we proceeded to read through all contributions to highlight gaps in the literature and outline future research avenues.

5.1. ESG data and ratings' quality, objectivity, reliability, and rigorousness

In order to make informed decisions, stakeholders must be able to objectively evaluate and compare different companies and investment opportunities using clear, appropriate, complete and standardised metrics. Nevertheless, ESG measurement is somehow problematic given the lack of common definitions, reporting standards and shared characteristics among each ESG component and across different rating providers (Billio *et al.*, 2021). The concerns of investors for an effective integration of ESG factors in their investment decisions are manifold and endanger reaching urgent societal goals. The paper by Friede (2019) uses meta-analysis to develop a comprehensive understanding of these impediments from a diverse set of papers. Supported by textual analysis, it identifies about 160 different topics, which are divided into different groups and aggregated along a four-pillar framework of market, firm, regulatory and individual-based impediments. As we would have expected, the most prominent impediments are found in the areas of (i) the quality of data, (ii) the absence of clear standards and definitions, and (iii) various behavioural biases.

Due to the complexity related to the analysis of ESG data – which are

themselves the result of complicated and unclear measurement and disclosure processes – interpretations are increasingly being provided by specialised organisations (sustainability rating agencies-SRAs) that facilitate the use of this information and the comparison of companies' sustainability performance (Boiral *et al.*, 2020).

By providing evaluations on corporate sustainability, SRAs act as intermediaries between companies who provide information in the field of ESG and stakeholders who use this information (Windolph, 2011; Escrig-Olmedo *et al.*, 2014). This aspect may constitute an additional problem when addressing the issue of the quality of ESG scores. In fact, even in an ideal case in which we are dealing with perfectly reliable non-financial information, it could be possible that they fail to reach investors because they are "lost in translation" when issued through third-party ESG information providers (Cho *et al.*, 2020).

Even though SRAs address a real need, their role and activities have been widely criticised in the literature. Several studies have highlighted the opacity and fuzziness of their methods of analysis (Stubbs *et al.*, 2013; SustainAbility, 2018). This lack of clarity could be explained by the fact that the ratings providers' sector is highly competitive, thus leading SRAs to keep their methods of analysis private in order to perform better than their peers (Boiral *et al.*, 2020). However, this aspect raises questions about the reliability of the scores produced, undermining the credibility of sustainable responsible investment products based on ESG information. Furthermore, having more accurate information on SRAs' measurement methods would be a plus for ESG data users. Similarly, it would be an advantage also for SRAs themselves because guaranteeing a higher level of transparency would make them more reliable. They should also benefit from a greater level of collaboration among themselves in order to save time and costs related to more in-depth ESG evaluations.

5.2 Possible ways to overcome the critical issues related to ESG data and ratings' quality, objectivity, reliability and rigorousness

It is worth noting that, among contributions belonging to cluster no. 2, we have found papers focusing on possible solutions to overcome the problem of the quality of data. Namely:

i. the external assurance of the non-financial information included in the corporate reports and
ii. the implementation of Distributed Ledger Technologies (DLTs) to create efficient, transparent and automated data collection processes.

5.2.1. Assurance of non-financial information

Currently, in most countries, companies are not obliged to have their sustainability reports audited by an external assurance provider because there are neither obligations concerning the standards to be applied in the preparation of these documents nor uniform assurance auditing standards (Schüler *et al.*, 2018; Quick and Inwinkl, P., 2020). However, over the last few years, many firms have started to submit voluntary external audits to provide credibility to their sustainability reports, strengthen their stakeholders' confidence in the information provided and avoid being accused of greenwashing (Owen *et al.*, 2008). Additionally, external audit support could also help companies to integrate the sustainability principle into their core business more consistently and to make it part of their strategic decisions. The audit may offer reasonable assurance or limited assurance, depending on the extent and depth of the assurance work undertaken by the assurance provider in relation to the company's sustainability report. The paper by Schüler *et al.* (2018) shows that 78.9% of the assurance reporting analysed has performed a limited/moderate assurance of companies' sustainability reports. Alongside the external assurance of sustainability reports through professional services, there are also other possible ways they can try to overcome the issue of ESG data reliability. Other studies have shown that other tools employed for obtaining ESG sustainability report certifications are internal assurance and the production of these reports in line with specific standard government regulatory requirements (Al-Shaer and Zamal., 2018; Velte, 2020; García-Sánchez *et al.*, 2022; Pozzoli *et al.*, 2022).

5.2.2 Distributed Ledgers Technologies (DLTs)

The lack of standardisation and the absence of a globally accepted framework for non-financial reporting has negative repercussions on collecting, processing and disclosing clear, objective and comparable data. Regarding ESG reporting and data sharing, instead, there is still a lack of comprehensive technological applications, resulting in manual management processes of inaccurate information, without proper data communication channels between participants. The paper by Cerchiaro *et al.* (2021) suggests that many of the obstacles related to non-financial reporting could be addressed by exploiting recent technological advances. For this reason, the above-mentioned authors suggested the implementation of Distributed Ledgers Technologies (DLTs) in order to make ESG reporting more efficient. DLTs are decentralised peer-to-peer transactional database enabling validated and consistent transactions between many participants in a network that consists of tamper-resistant nodes (Glaser, 2017; Beck *et al.*, 2018). In this framework, all participants

are equally privileged and interconnected, and there is no need for a centralised administrative authority because control is distributed among all nodes on a continuous basis. Potential benefits are manifold. DLTs could:

- simplify and automate processes, making complex and time-consuming activities easier to handle for all stakeholders. This is also beneficial for auditing and tracing processes because, once a transaction is executed in the network, it cannot be reversed;
- bring a higher level of transparency to the reporting process, as every record committed to the ledger can be accessed by all permitted participants. This reduces the risk of human error and greenwashing;
- reduce costs and the time allocation connected with the reporting activity, due to the fact that data can be quickly processed and stored;
- allow for improved data sharing and verifiability for all parties. All participants can work in a collaborative way, inputting raw ESG data into the ledger without the need of a central authority that coordinates and controls the whole process. This enhances communication among participants, reducing frictions from coordination-based tasks. Privacy is guaranteed thanks to the fact that all information is shared with permitted participants on a need-to-know basis — meaning that information is available only for those who need it for legitimate purposes, performance of duties or discharge of legal obligations. The access to the network could be extended to any third party in charge to review ESG information and revoked at any time.

The introduction of DLTs in the ESG reporting process brings with it some criticisms, too. For instance, implementing this kind of platform in an enterprise environment requires the existence of some specific technological infrastructures and capabilities. In addition, companies should have a good understanding of DLTs' mechanisms in order to implement them successfully (Centorrino *et al.*, 2022). This could be a critical aspect because there is an overall knowledge deficit in this field due to its recentness (Post *et al.*, 2018). However, limitations are not only related to technical aspects: questions and doubts around the ESG reporting process itself still remain.

5.3 ESG data and artificial intelligence

Traditionally, ESG ratings were exclusively produced by human research analysts on the basis of companies' disclosures, released articles and industry research.

However, innovations in financial technology are disrupting the environment of ESG ratings. Many questions have arisen about the extent to which AI

could affect businesses and the role it could play in helping investors and stakeholders to take optimal investment decisions. Within the last few years, the development of AI and machine learning have led to the creation of a new type of ESG ratings provider – called "*alternative*" (rather than "*traditional*"). In particular, it analyses companies' ESG risks and opportunities by collecting and processing unstructured data from internet sources using AI.

In fact, while in the past the assessment for inclusion in a sustainability index was based on information gathered from companies' online questionnaires built on a range of financially relevant sustainability criteria covering the economic, environmental and social dimensions (Bernardi and Demartini, 2019), nowadays information on ESG performance is collected from various sources and media and elaborated using AI.

The most relevant contribution to our study in the latter field is the Special Issue by Musleh Al-Sartawi *et al.* (2022). It is a collection of various papers examining the role of AI in helping creditors, investors and business managers to take optimal decisions. It encourages the readers to (i) reflect on the challenges and opportunities presented by AI in providing solutions to sustainability issues and (ii) to understand its value beyond a problem-solving tool. Alternative ESG rating providers use natural language processing (NLP) to extract the public sentiment on a company through the automatic synthetization of a large amount of unstructured data collected from online sources. Bala *et al.* (2021) have shown how AI is able to give structure to unstructured data by assigning quantitative values to qualitative information based on cognitive computing processes. In this way, the discussion on relevant ESG issues is no longer fed by corporations themselves only but involves many more stakeholders: there is a collection of third parties' public information on companies coming from NGOs, national and international media sources, academic journals and so on. For this reason, ESG knowledge production of alternative ESG rating providers is potentially more democratic and less subjective with respect to the traditional ones.

6. The quality of ESG data, ratings and artificial intelligence: current gaps and possible future research developments

In trying to understand the state-of-the-art of research on the ESG ratings and the quality of information gathered and provided to the market and the stakeholders, our findings reveal that authors interested in different fields of research (e.g., CSR, sustainability reporting, responsible investing, finance, economics of information) underline the lack of common standards in reporting and evaluating the ESG performance of individual companies.

Currently, there is a general bias in ESG data. Some themes/categories tend to be under-represented and some others over-represented – depending, for example, on the amount and quality of non-financial data that has been disclosed. Another critical aspect lies in the fact that there is no homogeneity in the way companies disclose their non-financial information.

However, as a result of constant pressure coming from markets, institutions and society with the aim of improving the quality of sustainability information, on 28 November 2022, the European Union Council gave its final approval to the corporate sustainability reporting directive (CSRD), offering the possibility of increasing the homogeneity of ESG data. Standards are being developed by the European Financial Reporting Advisory Group (EFRAG) and they will be shaped to EU policies, but also feed into and incorporate global initiatives.

Hence, the European Union will have its own sustainability reporting standards on ESG issues, marked by a multi-stakeholder perspective that (i) will be consistent with the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) and (ii) will reflect the disclosure requirements issued by the EU Green Taxonomy and the proposed Corporate Sustainability Due Diligence Directive (CSDDD). At the same time, the European standards are expected to contribute to the process of the global convergence of sustainability reporting standards, supporting the work already carried out by the International Sustainability Standards Board (ISSB).

In order to increase the dissemination and comparability of information, the CSRD also places an obligation to make the information contained in sustainability reports digital, using XHTML and XBRL markup language, already mandatory in Europe for all listed companies. This implies that a taxonomy of sustainability information with related "tags" (digital labels) should be prepared, and all digitised sustainability information should (i) be published according to a European Single Electronic Format (ESEF) and (ii) flow into the European Single Access Point (ESAP).

Hence, the adoption of the new CSRD and the European Single Electronic Format XHTML – as required by the Directive itself – call on especially accounting scholars to investigate if a new regulation design and adoption would greatly simplify the collection process and, consequently, the analysis of non-financial data.

Furthermore, the lack of transparency on the framework used by rating agencies in developing sustainability indices is a problem for both companies and investors. In this sense, further questions arise about the extent to which AI affects businesses and the role it must play in helping investors and stakeholders to take optimal decisions. This seems like one of the most promising fields for future research avenues.

AI allows sustainable investors to process massive amounts of data that hold crucial information for ESG investing. However, even if computer algorithms are able to analyse all the information available about a company efficiently and in a timely manner, managers and investors should be aware of their opportunities and shortcomings, while scholars should address propositions for advancing the research on these topics.

In fact, in a context where multiple sources and big data are available, it is necessary to consider the challenges presented by AI in providing solutions to sustainability issues.

We deem that AI's peculiar features generate some managerial, ethical and regulatory concerns over the following dimensions:

- AI governance: there is still inadequate management of and governance over AI applications, insufficient data protection mechanisms, lack of experienced AI talent and lack of training for managers and other responsible parties (Demartini and De Mauro, 2020; Demartini, 2021);
- Algorithms quality: apart from the problems related to input data, algorithms themselves are often biased. Since they are initially designed by individuals, subjectivity is inevitably involved in their formulation procedure, which is also usually not clear. Reasoned use of AI allows companies to create new market opportunities and become more competitive in an increasingly concentrated environment. That is why there is no incentive for market operators to disclose how algorithms are designed, what they do and how they make decisions. Furthermore, very little ESG data have been produced by the companies until now. This means that, since we do not have the historical information to be fed into these algorithms, the latter are not able to learn from the past and cannot be considered very efficient yet. In the future, much more non-financial information will be provided by the firms and fed into these algorithms, thus leading to an increase in the historical depth of ESG data and consequently to a greater predictive ability of these intelligent systems.

As accounting scholars, we need to analyse the strengths and limits of AI systems in order to make them useful for solving accounting and business problems and to determine the appropriate training and skills needed to allow accountants to control intelligent systems more easily. Hence, future research could examine the need for AI regulations and AI governance systems in corporations from a holistic perspective, because AI will be increasingly widespread in the processes that regulate information flows inside and outside the company.

7. Conclusions

The academic contributions that we have examined in this literature review adopt a partial perspective and address individual issues concerning the quality of ESG information, highlighting the limits that currently characterise ESG information by focusing on the role/behavior of the individual actors involved in the information process (i.e., issuers or intermediaries or final recipients), and/or on the different methods of coding, transmission, collection and decoding of ESG information.

In this complex and articulated picture, we believe that our research, contributes to previous studies by offering a broader perspective. Drawing on the theoretical framework of information theory, we deem that the quality of ESG information can only be guaranteed by clear coding rules and decoding of information, throughout the information process that goes from the source to the final recipient of the message. As suggested by the Shennon-Weaver model, sharing a code is a necessary condition for communicating. This implies not only a process of harmonisation and standardisation of the information produced by companies, as has been the case since the 1990s for financial information, but also a governed and transparent use of AI in the collection, processing and distribution of information by the actors involved in the information process.

Our bibliometric analysis shows that the debate on ESG information has so far mainly developed within the scientific community dealing with sustainable finance and responsible investing. Hence, a further contribution of our study is the call for future research on ESG information quality for accounting and management scholars, due to the relevance of this issue on the company's internal and external information flows, as well as on the company's control system. In addition to research implications, our study is of interest to legislators and practitioners alike for our insights into the potential but also the risks of applying AI to the processes of collecting, processing and transmitting ESG information.

There are some limitations of our study that should be considered, too.

First, the bibliographic database used to conduct the systematic review is largely comprehensive but not exhaustive. Further reviews could cover additional bibliographic sources, and unpublished papers could be included by looking at the main conferences or platforms that can provide work-in-progress papers.

Second, the search strategy and procedure attempted to encompass all the relevant studies. However, it is likely that some articles were not included because of the use of different keywords or the different categorisation by subject area in the bibliographic databases.

Third, within the thematic analysis, key themes have been identified and categorised through bibliometrics tools and our subjective interpretation and

understanding of the emerging categories. It is important to understand that though bibliometric analysis is an effective method of summarising and synthesising literature, it is not without limitations. The techniques chosen and the decisions associated with each step to perform bibliometric analysis are critical because they influence the results obtained and the interpretations that can be drawn from the analysis.

Notwithstanding these limitations, the bibliometric methodology can empower scholars to pursue ambitious retrospectives of business research. Indeed, even in business research as in other research fields, the use of bibliometric analysis can facilitate knowledge creation. Finally, bibliometric analysis is quantitative in nature, wherein the relationship between quantitative and qualitative results is based on the researcher's interpretation (Wallin, 2005). In this regard, scholars should take care when making qualitative assertions about bibliometric observations and supplement them with content analysis, where appropriate, as we did.

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