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An Examination of Assurance Practices on Carbon Emission Disclosures: Evidence From Italy and Spain

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ABSTRACT

This study explores corporate carbon assurance practices through a content analysis of the GHG assurance statements in the TCFD reports from a sample of Italian and Spanish companies listed on the FTSE MIB and IBEX 35 between 2021 and 2023. This study also analyses the reference to carbon information in the assurance statement of nonfinancial reports (NFRs). The results show that the assurance on GHG emissions is an underdeveloped and emerging issue. A three-fold approach can be outlined. The "early movers" companies draw up and assure the TCFD report. The "forthcomings" publish a TCFD report that is not assured. The "latecomers" do not publish a standalone GHG assurance statement but address carbon issues within their NFR assurance statement. Through the lens of legitimacy and signalling theories, this research contributes to understanding trends in GHG assurance and underlines the need to improve the reliability of carbon disclosure to meet stakeholder expectations and comply with the latest advancements in sustainability standards and regulations.

1 | Introduction

The growing interest in climate change has put greenhouse gas (GHG) emissions at the centre of the attention of national and international governments and other bodies (e.g., United Nations; European Union, Securities and Exchange Commission-SEC, etc.). Businesses are under increasing pressure to minimise their impact on the environment, and the proliferation of emissions standards and regulatory models has helped to transform the issue of climate change (and thus the impact of GHG emissions on the atmosphere) from an "ecological issue" to an "economic phenomenon" (Bebbington and Larrinaga-González 2008, 698), with effects on companies' reporting systems. The disclosure of information on greenhouse gases can be made to comply with national or supranational legal or regulatory constraints (e.g., United Kingdom Financial Reporting Council 2018; United States Environmental Protection Agency 2020; SEC 2024), or it can be done on an entirely voluntary basis by providing this information in a section of nonfinancial reports (NFRs) (e.g., sustainability report, integrated report, nonfinancial statement,

management report), in standalone emissions reports (e.g., carbon report, GHG emissions reporting, GHG statement, TCFD report), or through participation in voluntary disclosure initiatives (e.g., CDP).

The results of KPMG surveys published over the last 20 years have shown that the world's largest and mid-cap companies (G250 and N100) are paying increasing attention to reporting their carbon performance. In particular, the number of companies recognising climate change risk has increased significantly. This growth is due in large part to the work of the Task Force on Climate-related Financial Disclosures (TCFD) (KPMG 2017, 2020, 2022, 2024b).

Meanwhile, the growing demand for transparency from a wide range of stakeholders regarding the positive and negative impacts of corporate activities on climate change, as well as new legislation on carbon reporting, has increased the need for rigorous and reliable disclosure of emissions (Simnett, Nugent, et al. 2009; Olson 2010; Green and Zhou 2013; Datt et al. 2018;

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Zhou 2022). Companies can use carbon reporting and assurance as a positive signal to stakeholders regarding their commitment to managing carbon emission issues, thereby gaining their support and maintaining legitimacy. The assurance of carbon information by an independent third party is aimed at improving the credibility and reliability of the reported data, supporting the reduction of the existing information asymmetry between stakeholders and company management, highlighting any discrepancies between what is reported and the real company performance, as well as supporting corporate decision making (Blackwell et al. 1998; Simnett, Vanstraelen, et al. 2009; Giannarakis et al. 2018; Datt et al. 2022).

The need for reliable disclosure of greenhouse gas emissions has led to a strong demand for assurance, confirmed by the IAASB's approval of a standard on assurance engagement of Greenhouse gas statements (June 2012). This standard is to be read and adopted in accordance with the International Standard on Assurance Engagement (ISAE) 3000, the most widely used standard for the assurance of nonfinancial information. In fact, ISAE 3410 "(...) expands on how ISAE 3000 is to be applied in an assurance engagement to report on an entity's GHG statement" (ISAE 3410, par. 9, IAASB 2013a). It is used both for standalone GHG statement and in the case of GHG information included in a different report, such as a sustainability report.

The increasing focus on climate change and carbon reporting, coupled with the largely voluntary assurance of carbon reporting, makes it interesting to examine trends in the assurance of carbon reporting and of carbon information in other NFRs. To this aim, this study explores the carbon assurance practices of a sample of Italian and Spanish companies listed on the FTSE MIB and IBEX-35 for the 3 years 2021–2023. Considering that carbon information could be reported in a TCFD report and/or in an NFR, our study aims to analyse both the assurance statements of TCFD reports prepared by the companies in our sample and, for companies that do not publish a TCFD report and draw up a sustainability report, to explore the reference to carbon information in the assurance statements of sustainability reports. Therefore, we conducted a content analysis of carbon assurance statements in climate reports, as well as an investigation into references to carbon issues in NFR assurance statements.

Through the lens of signalling and legitimacy theory, our study contributes to understanding trends in firms assuring their carbon emissions reports and carbon information in NFRs. Therefore, our study extends the existing studies of assurance in the sustainability context (e.g., Peters and Romi 2015; Rossi and Tarquinio 2017; Martínez-Ferrero and García-Sánchez 2017; Sierra García et al. 2022; Harindahyani and Agustia 2023), as well as the carbon context (Martinov-Bennie 2012; Green and Zhou 2013; Datt et al. 2020, 2022; Dutta and Dutta 2021; Simic et al. 2023; Luo et al. 2023). The study also provides insight into types of assurance providers, levels of assurance provided, the specific firms providing assurance services, and the assurance frameworks used to assure carbon emissions reports. In this regard, previous studies have not examined the content of carbon assurance statements. Hence, this study provides practical contributions on corporate behaviours towards the adoption of GHG assurance.

The reason for analysing Italian and Spanish companies lies in the similarities between the two countries. Previous literature has identified the main commonalities, namely climate vulnerability, culture, geographical conditions, urban configurations, governance structures, stakeholder orientation, and legal system (De Gregorio Hurtado et al. 2015; Posadas and Tarquinio 2021; Posadas et al. 2023). Moreover, both are affected by European climate policies (De Gregorio Hurtado et al. 2015); no previous literature has examined the assurance practices of these two countries with reference to carbon emission disclosures.

The results show that Italian and Spanish NFRs are generally assured. Instead, the assurance of TCFD reports is not widespread; there are few cases in which assurance statements relating to NFRs contain a specific reference to GHG emissions disclosed in NFRs.

Our analysis reveals companies adopting a three-fold approach to carbon reporting and assurance. The “early movers” companies are those that have drawn up and assured a TCFD report. The “forthcoming” companies are those that publish a TCFD report, but a third party does not assure this report. The “late-comers” comprise both companies that do not publish a TCFD report, those that draw up a NFR assured, but the assurance statement does not contain an explicit reference to carbon issues, and companies for which it is possible to find a precise and explicit reference to the assurance of carbon information.

The remainder of the paper is organised as follows. Section 2 provides background information on the institutional setting and prior literature on carbon emissions assurance. The theoretical framework is outlined in Section 3, while Section 4 describes the research method. Section 5 presents the results, and Section 6 concludes the paper.

2 | Background

Research on carbon assurance develops along two main streams, one concerning regulatory advancements and the other drawing on existing literature on assurance of sustainability and climate information.

2.1 | Institutional Setting

In recent years, Italian and Spanish companies have emerged as leading adopters of sustainability reporting and assurance practices. According to the latest KPMG surveys, they have achieved similar high national rates of sustainability reporting for 2022 and 2024 (KPMG 2022, 2024b), thus confirming these firms' commitment to sustainability issues. Concurrently, Italy and Spain are among the top 10 countries adopting assurance on sustainability reporting (KPMG 2022).

A key role in climate change reporting was provided by the TCFD, which developed a set of recommendations to support companies in disclosing climate-related financial information, risks, and opportunities, as well as to report clear, comparable, and consistent information to address investors' demand (TCFD 2017). The framework applies across sectors;

it is issued to guide companies in assessing the financial impacts, risks, and opportunities related to climate change (TCFD 2017). The recommendations cover four core areas: governance, strategy, risk management, and metrics and targets; for each, the Task Force sets some detailed disclosure requirements, including defining categories for climate-related risks and opportunities.

In addition to the TCFD, other organisations have elaborated studies, published documents, and approved standards aimed at quantifying and reporting GHG emissions in standalone reports, within NFRs (CDSB 2012, 2015; WBCSD and WRI 2004; UNI EN ISO 14064-1 2019; UNI EN ISO 14064-3 2019; GRI Standards 2021), or in databases such as the CDP. Furthermore, standards for reporting on this topic have recently been approved at European (EFRAG, ESRS E1) and international (ISSB, IFRS S2) levels.

It should also be noted that in November 2024, the IAASB issued the International Standard on Sustainability Assurance (ISSA), General Requirements for Sustainability Assurance Engagements (IAASB 2024). However, considering that GHG information may be part of broader sustainability information, and the practitioner may or may not be issuing a separate conclusion on this data, the IAASB determined that ISSA 5000 should apply to all assurance engagements on sustainability information, including climate and emissions (IAASB 2024). The assurance obligation has also been confirmed in the Omnibus package proposal as regards the limited level; the adoption of reasonable assurance has been removed to simplify the reporting framework and limit the increasing costs of assurance for organisations (EC 2025).

Due to the unique nature of corporate climate change-related information and the increasing demand for assurance of this data, the International Auditing and Assurance Standards Board (IAASB) has also issued a separate assurance standard; we refer to the ISAE 3410, Assurance Engagements on Greenhouse Gas Emissions (IAASB 2013a). The ISAE 3410 can be considered a “subject-matter specific assurance standards” (ISAE 3410, par. 8) that operates under the ISAE 3000 (Revised), Assurance Engagements Other Than Audits or Reviews of Historical Financial Information, which applies to the assurance of general sustainability information.

As in the case of ISAE 3000, the objective of an engagement under ISAE 3410 is to obtain a reasonable or limited assurance of the GHG statement to highlight that the document does not contain significant errors due to fraud or mistakes. In the case of reasonable assurance, the assurance provider considers that the GHG statement has been prepared, in all its material aspects, in compliance with the criteria adopted by the company to quantify and report its emissions (applicable criteria). In the case of limited assurance, on the other hand, the provider declares that nothing that has come to its attention suggests that, based on the procedures carried out and the evidence obtained, the GHG statement has not been prepared, in all its material aspects, in compliance with the “applicable criteria”.

The centrality of the management of GHG emissions and reliability of carbon disclosure has also led AccountAbility to develop

a “Guidance on Assuring GHG Emissions with AA1000AS v3 for Assurance Providers” (Accountability 2024). This guidance is a new supplement to the Assurance Standard AA1000AS v3 (Accountability 2020) and it is intended to be compatible with other global reporting standards and to help professionals assess GHG emissions data and processes. However, despite the importance attached to the assurance of carbon information, it remains largely a voluntary practice (Green and Zhou 2013; Hassan et al. 2020; Gillet-Monjarret 2022; Datt et al. 2022; Simic et al. 2023).

2.2 | Literature Review

The last few years have seen the spread of sustainability reports, and in parallel, what has emerged in the literature is a lack of confidence in the reliability of the data communicated in the reports (Mori Junior et al. 2014; Farooq and De Villiers 2019; Martinez et al. 2021). Even if the development of carbon reporting is not comparable to that of sustainability reports, the need for third-party assurance of carbon reports also emerged to ensure greater credibility and reliability of the information disclosed (Alkebsee et al. 2025). Assurance can act as a persuasive tool for stakeholders (Diouf and Boiral 2017), enabling them to obtain additional information on the quality of the assured reports and support their judgement and economic decisions (Simnett, Nugent, et al. 2009; Huggins et al. 2011; Michelon et al. 2019). However, corporate climate change-related information stands out from other sustainability information due to the inclusion of GHG data. This GHG information is noted to be more akin to financial information in terms of its quantifiability, setting it apart from other nonfinancial data related to environmental issues (Zhou et al. 2016; Dutta and Dutta 2021).

However, there is a substantial difference between the assurance of emissions and other sustainability information. As noted by Zhou et al. (2016), the assurance of GHG information is more similar to that of financial information because emissions information is, by its very nature, more quantifiable than much of the other nonfinancial information (in particular, it is possible to translate emissions into the standard measure of tonnes of CO₂ equivalent). This makes it easier for the assurance provider to verify, for example, risks and evaluate materiality.

The assurance market of nonfinancial information is characterised by two principal assurance providers: the accounting and the nonaccounting assurance providers. Accounting assurance providers are the most influential players in the assurance market, which is dominated by the Big 4 firms (KPMG 2022). These providers generally adopt the ISAE 3000 and 3410 for their assurance engagement. Nonaccountant assurance providers are usually engineers and quality assurance firms (Mori Junior et al. 2014; Martínez-Ferrero and García-Sánchez 2017; Hummel et al. 2019). When nonaccounting providers verify GHG statements, one of the most frequently adopted standards is ISO 14064-3. This standard, similarly to ISAE 3410, specifies the requirements to be met by the validators/verifiers of greenhouse gas assertions, establishes the level of assurance, the objectives, the criteria, and the verification process to be carried out on the data and information and control systems, and then leads to the preparation of the validation/verification statement.

Huggins et al. (2011) pointed out that there are few differences between ISAE 3410 and ISO 14064-3. They also underlined that the contacts between the IAASB and ISO point to the possibility that the differences between the two standards may become even smaller.

The assurance of GHG statements has only recently been the subject of interest in the accounting literature, and the scientific evidence is still scarce. The research published focused mainly on the examination of current assurance practices (e.g., determinants of assurance, choice of assurance provider) (Green and Zhou 2013; Zhou et al. 2016; Datt et al. 2022; Ryan and Tiller 2022; Luo and Zhang 2024), on identifying corporate incentives for external carbon assurance (Bui et al. 2021; Rohani et al. 2023; Simic et al. 2023), and on the impacts of assurance on the level and quality of carbon disclosure (Dutta and Dutta 2021; Luo et al. 2023).

Our study is rooted in the first group of research. In particular, Green and Zhou (2013) documented the assurance practices for carbon emissions disclosures among 3008 companies across 43 countries from 2006 to 2008. The authors highlight that companies in Europe and carbon-intensive industries are the main drivers of demand for assurance services, often engaging specialist assurers when the assurance is only on the disclosure of carbon emissions and engaging accounting assurance providers when the assurance is on sustainability data. Zhou et al. (2016), with reference to a sample of 971 companies, investigated the determinants of assurance of GHG information and assurance provider choice. The results of this study highlight that business culture and law systems influence both disclosure and choice of the provider, and in particular countries, more “stakeholder-oriented” prefer the assurance of accounting providers. Datt et al. (2022) analysed data from 58 countries from the Carbon Disclosure Project (CDP) database between 2010 and 2017. The study underlines that more firms are seeking assurance for their carbon emissions reports, often using specialist providers and obtaining a limited assurance of reports. The research also emphasises the variety of assurance frameworks used to assure carbon emissions disclosures. Ryan and Tiller (2022) documented market practices related to GHG emission reporting in large New Zealand entities. The authors observed a moderate level of voluntary emissions reporting and limited use of assurance in about half of the investigated companies. GHG Protocol and ISO 14064-1 are the most widely used standards for measuring GHG emissions. Luo and Zhang (2024) explored the association between voluntary carbon assurance and climate uncertainty, demonstrating that climate instability (i.e., the inability to predict the impact of climate change on firms) positively affects the decision to voluntarily adopt external carbon assurance to meet stakeholders’ requests for credible information.

More recent studies (Alkebeese et al. 2025; Issa 2025; Luo and Pan 2025; Safiullah et al. 2025) have instead focused on the effects of GHG assurance on performance, corporate investment efficiency, and credit ratings. Alkebeese et al. (2025) have investigated the link between GHG emissions assurance and carbon performance, revealing a negative association between the two variables; however, they confirmed that using an accounting firm provider, particularly a Big 4 firm, leads to better carbon performance. Concurrently, Issa (2025) provides evidence of

the positive impact of external assurance practices on GHG reduction initiatives and the key role of sustainability committees in promoting the adoption of sustainability assurance. Luo and Pan (2025) have explored the impact of carbon assurance on corporate investment efficiency and its implications for disclosure; the authors showed that carbon assurance improves environmental performance and information quality, reducing information asymmetry. Similarly, Safiullah et al. (2025) have highlighted the benefits of carbon assurance: it boosts firm-level credit ratings, mitigates information asymmetry, and acts as a strategic signal reflecting the quality and credibility of carbon reporting.

In summary, the attention to carbon emissions is progressively growing, bringing with it the need for more reliable and credible carbon emission information. Assurance is an essential tool to enhance confidence in carbon disclosure. Due to the limited literature on these important issues, there is insufficient knowledge on the approach to GHG emissions reporting followed by companies (e.g., information in the standalone report or disclosed inside sustainability report or both), on the choice of assurance provider, the assurance standards used, and the level of assurance provided. The current study attempts to address these gaps, verifying the carbon reporting and assurance approach followed by companies from two countries, focusing on the content of assurance statements drawn up with reference to the TCFD reports and the assurance of GHG information disclosed in NFR. Indeed, no previous research has qualitatively analysed the content of carbon assurance statements; hence, this study provides a first contribution towards monitoring the behaviour of a sample of companies as regards the assurance of climate information.

3 | Theoretical Framework

Several theories have been used to explain voluntary reporting on carbon emissions (Guo et al. 2022) and invoked for general assurance of sustainability reports (Tyson and Adams 2020). Among the theoretical frameworks used for carbon reporting and sustainability assurance, legitimacy theory and signalling theory can provide a theoretical lens to analyse the field of carbon emissions assurance.

Utilising both theories allows for a multi-dimensional analysis. Legitimacy theory explains why companies feel compelled to report on climate change issues and seek assurance for their reports. On the other hand, signalling theory explains how companies communicate their efforts in managing climate issues and what they hope to achieve. Together, these theories provide a richer and more nuanced understanding of corporate behaviour in climate reporting and assurance.

Legitimacy theory suggests that companies try to align their operations with societal norms, values, and beliefs to maintain their social contract with the communities they serve. If a company is perceived as violating this contract, its survival could be at risk (Suchman 1995; Deegan 2002). Consequently, companies aim to be deemed legitimate by stakeholders and may seek carbon emissions assurance to increase the transparency and credibility of their disclosed information (Simnett, Nugent,

et al. 2009; Zhou 2022), manage reputational risks (Hartlieb and Eierle 2022) and thereby increase their legitimacy. As noted above, climate change and the actions taken by companies to mitigate global warming issues are increasingly considered topics of interest by stakeholders. Therefore, based on this theory, companies provide voluntary climate change disclosure and assurance to protect stakeholders' interests and influence the community's perceptions of the legitimacy of their behaviour (Rossi and Tarquinio 2017; Jaggi et al. 2018; Datt et al. 2022).

Signalling theory is strictly connected to legitimacy theory, and it is focused on the communication between two actors: the signaller, who sends information considered useful for the receivers, and the receiver, who interprets the signal (Connelly et al. 2011). Signalling theory, initially proposed in labour market research (Spence 1973), has been increasingly used in research concerning sustainability reporting (Campbell et al. 2001; Mahoney et al. 2013; Ching and Gerab 2017; Zerbini 2017) and more recently on carbon disclosure and assurance (Luo et al. 2023).

According to the signalling theory, companies can use climate change disclosure and assurance as a positive signal of their commitment to reducing emissions and, in particular, as a signal to investors of their ability to manage climate change risks and prevent the greenwashing phenomenon (Prado-Lorenzo et al. 2009; Green and Zhou 2013). Indeed, assurance reinforces the transparency and credibility of carbon and GHG information disclosed (Bui et al. 2021; Datt et al. 2020; Alkebeese et al. 2025) and can be considered a signal of a superior commitment to carbon emission reduction.

All these arguments can help explain the different approaches to reporting on climate change information and the use of assurance.

4 | Methodology

This study performs a content analysis of carbon assurance statements in TCFD reports and investigates the occurrence of carbon references in the assurance statements of other NFRs.

The analysis is conducted on a sample of Italian and Spanish companies listed on the FTSE MIB and IBEX-35. These are the main benchmark indices of the Italian and Spanish stock markets, reflecting leading, highly liquid, and capitalised companies; thus, they are the most representative of the market.

The sample selection consists of two stages, covering the three-year period 2021, 2022, and 2023, and updated to March 2024. The starting year chosen for this analysis is 2021 for several reasons. The majority of companies in the sample only began defining a climate strategy and complying with the TCFD recommendations in 2021; therefore, they do not have a climate report before 2021. In the Italian sample, only 8% of companies had published a TCFD report before 2021, compared to 11% in the Spanish sample. Furthermore, the results of the 2021 TCFD Status Report reveal that the number of TCFD member organisations has grown compared to the previous year (TCFD 2021). In 2021, European companies also increased their average disclosure by 15% since 2019 (TCFD 2021).

The 40 companies listed on the Italian FTSE MIB and the 35 listed on the Spanish IBEX-35 were selected. The websites of all 75 companies in the initial sample were reviewed to verify whether they published a TCFD report. For companies with a TCFD report, we checked for the presence of a carbon assurance statement and conducted a content analysis to identify its key features.

In the second stage, we focused on companies that did not publish a TCFD report, but did release an NFR. For these companies, we examined the assurance statements within the NFRs to assess whether they included assurance related to GHG emissions.

The data extraction process resulted in two distinct clusters:

1. Companies that publish an assurance TCFD report;
2. Companies that publish only an NFR with GHG emissions assurance included in the NFR's assurance statement.

After selecting the final sample and verifying the presence or absence of TCFD reports, the analysis focused on the content of the assurance statements. The following items were assessed: the purpose of the assurance, the assurance provider, the standards adopted, the level of assurance, and the conclusions provided. Selected excerpts from the assurance statements were included to illustrate significant patterns identified during the document analysis, providing concrete examples of the content of these documents. Regarding NFRs, the company's adoption of the TCFD recommendations was verified, and subsequently, the reference to GHG emissions in the assurance statements was made.

Table 1 summarises the sample composition and its structuring into the two clusters over the three-year period.

The final sample consists of 21 companies, 15 Spanish and 6 Italian. Regarding industry affiliation, the sectors were aligned with the Global Industry Classification Standard (GICS), a universal industry classification framework that aims to improve the transparency and efficiency of the investment process,

TABLE 1 | Sample overview.

Starting sample for each of the 3 years	Italy				Spain			
	40 companies				35 companies			
	Carbon assurance statement in TCFD reports				Assurance of GHG emissions in the assurance statement of NFRs			
Final sample	Italy		Spain		Italy		Spain	
2021	2	5%	2	5.7%	3	7.5%	4	11.4%
2022	3	7.5%	4	11.4%	3	7.5%	6	17.1%
2023	0	0%	1	2.9%	1	2.5%	1	2.9%
Total	5	12.5%	7	20%	7	17.5%	11	31.4%

ranging from the most general sectors to the most specialised sub-industries (MSCI 2024). As shown in Figure 1, companies in the final sample belong mostly and equally to the financial and energy sectors (28.6%).

5 | Results and Discussion

The analysis highlights the limited diffusion of carbon assurance practices among the companies in the sample over the three-year period. In particular, three approaches to carbon assurance can be identified, resulting in three different behaviours:

- Companies that draw up a TCFD report, and the report is assured by a third party; therefore, these companies have developed a well-established behaviour over time and can be described as “early movers” in terms of their proactivity.
- Companies that draw up a TCFD report, but the report is not assured by a third party. These companies may include

a reference to GHG emissions in the assurance of their NFRs. Therefore, they can be considered as “forthcoming” companies that might assure their TCFD reports in the future.

- Companies that do not draw up a TCFD report may adopt the TCFD recommendations in their NFRs and may or may not incorporate some references to GHG emissions into the assurance statement of the NFR. These companies are “latecomers”, as they should be encouraged to integrate carbon issues in their assurance statement and produce a standalone TCFD report.

Figure 2 provides an overview of the three clusters discussed above.

5.1 | Early Movers Companies

As regards the early movers companies, the content of the assurance statements released by a third party was analysed.

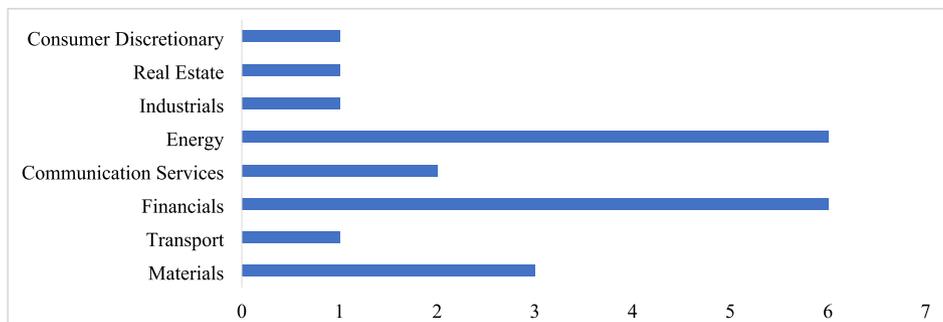


FIGURE 1 | Companies classification by sector.

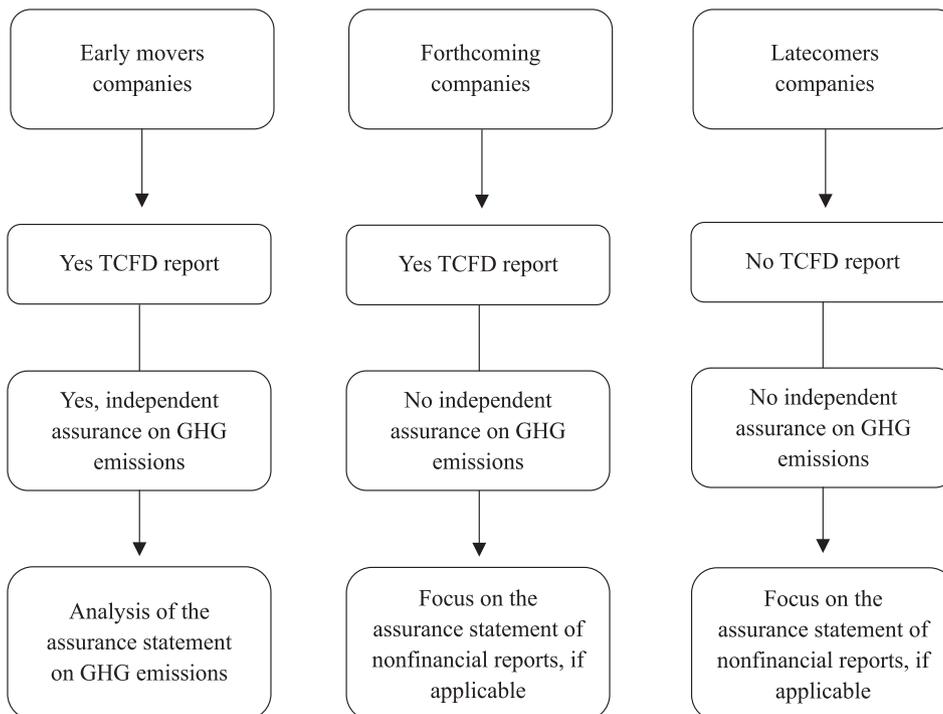


FIGURE 2 | Overview of the three behavioural patterns.

Notably, the common feature of almost all companies in this cluster (91.7%) is the engagement of an independent accounting firm as an assurance provider. Indeed, in only one Spanish TCFD report, the assurance provider is a nonaccounting firm represented by an engineering consultant. Previous studies (Datt et al. 2020, 2022) have investigated the reasons for choosing assurance providers. Datt et al. (2020) underline that the choice of assurance provider is a strategic business decision and that being exposed to greater stakeholder pressure and legitimacy threats leads to selecting accounting assurance providers. The latter are perceived to be independent and qualified to provide more reliable carbon information (Datt et al. 2020). On the other hand, companies seeking to improve their carbon management system generally prefer consulting firms with technical knowledge and skills in climate issues (Datt et al. 2020, 2022). The analysis shows that the most common accounting assurance provider is PricewaterhouseCoopers for 50% of the sample (16.7% for Italian TCFD reports and 33.3% for Spanish TCFD reports). Furthermore, it is interesting to note that the assurance provider is the same for most companies presenting both the assurance of TCFD reports and the assurance of NFRs (66.7% divided equally into 33.3% for Italian and Spanish companies); this result does not surprise us, indeed it is an expression of a complementary role between TCFD and sustainability reporting. All the accounting assurance providers declare their independence in the assurance statement as follows: “We have complied with the independence and other ethical requirements of the International Code of Ethics for Professional Accountants issued by the International Ethics Standards Board for Accountants (IESBA Code), which is founded on fundamental principles of integrity, objectivity, professional competence and due care, confidentiality and professional behaviour” (Independence statement of accounting assurance providers). Compliance with the IESBA Code is also confirmed by the ISAE 3000 Standard, which considers its content to be ethical requirements (IAASB 2013b). Simnett, Nugent, and Huggins (2009) emphasise that the adoption of a code of ethics supports the development of assurance activities and ensures the quality of the standards applied.

Although assurance statements are included in standalone TCFD reports, their scope differs. Two Italian assurance providers (16.7%) state that the purpose of the assurance activity is to verify compliance with the TCFD framework. The 41.7% of assurance statements within TCFD reports clearly state that assurance is performed on direct and indirect Scope 1, 2, and 3 GHG emissions (25% for Italian assurance statements and 16.7% for Spanish statements). The remaining 41.7% do not specify the scope, as they generally report the assurance on selected ESG indicators, without specifying Scopes 1, 2, and 3; this percentage is split between 25% of Italian assurance providers and 16.7% of Spanish providers.

The analysis revealed the dominance of ISAE 3000 (Revised) and ISAE 3410 among Italian and Spanish accounting assurance providers. Notably, only a small number of assurance statements involve the adoption of both standards (16.7% for Italian assurance providers only); ISAE 3000 alone is applied by 33.3% of assurance providers (16.7% for both Italian and Spanish providers) and ISAE 3410 alone in 41.7% of assurance statements (8.3% for Italian providers and 33.3% for Spanish providers). In

contrast, the only Spanish nonaccounting provider (8.3%) adopted ISO 14064 as the assurance standard.

As underlined in Section 2, the ISAE 3000 supports the assurance of information other than historical financial information; it is an “umbrella standard” enclosing the specific topic standard ISAE 3410 to provide targeted guidance on assurance of GHG statements. ISAE 3000 guides the assurance provider on the steps to perform the assurance activity. It includes two levels of assurance engagement to be applied: reasonable assurance and limited assurance. The first reduces the risk of errors or misstated information to a low level, while the limited assurance engagement reduces this risk to a moderate level (Green and Zhou 2013; Rohani et al. 2023). ISAE 3410 is the International Standard on Assurance Engagements on Greenhouse Gas Statements adopted for assurance on GHG emissions since 2013. It is a topic-specific standard aiming to ascertain the absence of mistakes or fraud in GHG statements. ISAE 3410 defines the GHG statement as a document that describes the constituent elements and quantifies an organisation's GHG emissions for a period of time, together with possible explanations of the methodologies applied for the measurements (IAASB 2013a). ISAE 3410 can be applied to carbon assurance within sustainability reports or standalone GHG emissions reports, such as the TCFD report (Dutta and Dutta 2021). The aim of ISAE 3410 is to “obtain a limited or reasonable assurance about whether the GHG statement is free from material misstatement, whether due to fraud or error, thereby enabling the practitioner to express a conclusion conveying that level of assurance” (IAASB 2013a, 6).

These considerations are also reflected in the assurance statements drawn up by the assurance providers. For example:

The procedures performed in a limited assurance engagement vary in nature and timing from, and are less in extent than for a reasonable assurance engagement. Consequently, the level of assurance obtained in a limited assurance engagement is lower than that of a reasonable assurance engagement” (Acciona, 2021).

A limited assurance engagement is substantially less in scope than a reasonable assurance engagement conducted in accordance with ISAE 3000 revised and consequently does not enable us to obtain assurance that we would become aware of all significant matters that might be identified in a reasonable assurance engagement (Intesa Sanpaolo, 2022).

In this cluster, a prevalence of limited assurance engagement is observed for 66.6% of the sample, of which 25% are Italian and 41.6% are Spanish assurance statements. In contrast, reasonable assurance alone is not found, while the mixed approach of the two levels is detected in 25% of the statements, of which 16.7% are Italian and 8.3% Spanish.

Below is an example of a mixed approach referred to in the assurance statements of two companies:

We have been engaged to perform an engagement that includes reasonable assurance on the direct (Scope 1) and indirect (Scope 2) Greenhouse Gases (hereinafter “GHG”) emissions and limited assurance on the indirect (Scope 3) GHG emissions, on the Lifecycle GHG Emissions Indicators, on the Net Zero Carbon Footprint Eni and on the Net Zero Carbon Footprint Upstream (Scope 1 and 2) on an equity basis disclosed in the “Statement on GHG Accounting and Reporting—Year 2022” of Eni Group (hereinafter the “Group”) for the year ended 31 December 2022 (hereinafter the “GHG Statement” Eni, 2022).

Our responsibility is to carry out a review to provide reasonable assurance on the preparation and presentation of scope 1 and 2 indicators, a limited assurance review on the preparation and presentation of scope 3 indicators, and to express a conclusion based on the work performed (Acciona, 2021).

Regarding the combined adoption of ISAE 3000 and ISAE 3410, which occurs in only 16.7% of the Italian assurance statements, the two levels of assurance are applied to different information. Notably, reasonable assurance is adopted for Scope 1 and Scope 2 GHG emissions, while limited assurance for Scope 3 GHG emissions. On the other hand, previous research (Green and Zhou 2013) points out that nonaccounting providers widely use ISO 14064-3 to assure emissions disclosure. This standard explains both the measurement and disclosure of GHG emissions and removals (ISO 14064-1), and the guidelines for the verification of GHG statements (ISO 14064-3).

The adoption of reasonable or limited assurance level also shapes the assurance provider’s final conclusion. With reasonable assurance, the conclusion is expressed in positive form in both Italian and Spanish statements. An example is given hereafter:

In our opinion, Eni Group’s direct (Scope 1) and indirect (Scope 2) GHG emissions for the year ended 31 December 2022 disclosed in the GHG Statement are prepared, in all material respects, in accordance with the applicable criteria, as indicated in the Annex “References” of the GHG Statement (Eni, 2022).

Conversely, a limited assurance engagement results in a negative assurance conclusion, as the extent of assurance is lower than reasonable assurance. The following is an example:

Based on the procedures we have performed and the evidence we have obtained, nothing has come to our attention which may lead us to believe that Ferrovial Corporación, S.A. and its subsidiaries GHG Statement for the financial year ended December 31, 2022 is not prepared, in all material aspects, in accordance with the internal procedure “Calculation and Report of Carbon Footprint” of Ferrovial, which is described in

the report Ferrovial Climate Strategy 2022 (Ferrovial, 2022).

Table 2 describes and summarises the characteristics of the cluster discussed above.

Relating to assurance procedures and investigation methods, assurance providers in both countries perform the same activities, that is, analysis of documentation, meetings with staff from different departments, analysis of the procedures used for validating data, evaluation of methods for quantifying data, and analytical and substantive testing to verify the information used in the GHG statement. Some assurance statements (50% represented by Spanish statements only) include the GHG statement for the reporting year as an annex explaining the GHG emissions inventory and estimation methods. Notably, it refers mainly to

TABLE 2 | Characteristics of cluster a.

Scope of assurance						
	2021		2022		2023	
GHG emissions (Scopes 1, 2, and 3)	3	25%	2	16.7%	0	0%
TCFD compliance	0	0%	2	16.7%	0	0%
Not specified	2	16.7%	2	16.7%	1	8.3%
Total	12 (100%)					
Type of accounting provider						
	2021		2022		2023	
Accounting provider	5	41.7%	5	41.7%	1	8.3%
Nonaccounting provider	0	0%	1	8.3%	0	0%
Total	12 (100%)					
Assurance standard						
	2021		2022		2023	
ISAE 3000 (Revised) only	0	0%	3	25%	1	8.3%
ISAE 3410 only	4	33.3%	1	8.3%	0	0%
ISAE 3000 (Revised) + ISAE 3410	1	8.3%	1	8.3%	0	0%
ISO 14064 only	0	0%	1	8.3%	0	0%
Total	12 (100%)					
Level of assurance engagement						
	2021		2022		2023	
Limited only	3	25%	4	33.3%	1	8.3%
Reasonable only	0	0%	0	0%	0	0%
Limited + Reasonable	2	16.7%	1	8.3%	0	0%
Not specified	0	0%	1	8.3%	0	0%
Total	12 (100%)					

Scope 1, 2 and 3 GHG emissions and performance indicators related to energy consumption.

Regarding the sector, most early mover companies (41.7%) belong to the financial sector and are banks. This suggests their increasing attention to climate reporting and assurance. The latest KPMG report on banks' climate-related disclosures (2024) supports our findings by highlighting the increasing assurance on climate and emissions information for banks that disclose climate information (KPMG 2024a). These results underline that the companies in this cluster have already consolidated GHG emissions assurance practices drawn up by external assurance providers, thus integrating assurance into the corporate reporting process.

5.2 | Forthcoming Companies

The second cluster comprises companies that produce a TCFD report, but this report is not assured. However, these companies publish an assured NFR, and the assurance statement issued by the assurance provider may or may not contain a reference to the assurance of GHG issues. Notably, 18 assurance statements contain a specific reference to GHG emissions over the three-year period. However, only 4 assurance statements refer to companies that also publish a TCFD report and provide a reference to GHG emissions in the assurance statement of the NFRs; instead, 14 do not publish a TCFD report and include a reference to the assurance of GHG emissions in the assurance statement of NFR. The enterprises in this cluster belong to sectors that, for the most part, are the same as the enterprises in the first cluster.

In terms of the content of the assurance statement, with reference to companies in (cluster b), it is possible to detect different approaches to assurance of GHG emissions within the assurance statement of NFR. The largest number of assurance statements (about 50%, of which 25% are Italian and 25% Spanish) conduct limited or reasonable assurance on specific GRI economic, environmental, and/or social performance indicators disclosed in the NFR. As regards climate change, the most recurring environmental indicators subjected to assurance are those related to energy consumption and emissions released. These sets of indicators are GRI 301 (Materials), GRI 302 (Energy), GRI 303 (Water and Effluents), GRI 304 (Biodiversity), GRI 305 (Emissions), GRI 306 (Waste).

A further approach adopted in assurance statements of NFRs is to assure the GHG emissions inventory, thus without reference to specific GRI indicators, but to Scope 1, 2, and 3 of GHG emissions. This concerns only one Spanish company and its NFR. Still, only one Spanish company is found to have an assurance statement that verifies compliance with the TCFD recommendations as regards disclosure of climate-related risks.

Considering that the companies in this cluster produce a TCFD report, and that the assurance statement issued with reference to the NFR contains a reference to GHG issues, it can be assumed that these companies are more likely to have the climate report also assured in the future; therefore, this cluster has to be monitored to verify the assurance practices in the coming years.

5.3 | Latecomers Companies

The last group of results refers to companies encouraged to publish and assure standalone TCFD reports. Companies of this cluster do not publish a TCFD report but can adopt the TCFD recommendations in their NFRs by providing the TCFD index linking the content of the NFR to the disclosure requirements of the framework. In this cluster, the assurance statement of the NFR may or may not contain a specific reference to GHG issues. Therefore, this cluster comprises companies that do not publish a TCFD report and do not mention carbon issues in the assurance statement of their NFRs in any of the 3 years (about 45.3% of the total sample over the 3 years, of which 26.7% are Italian and 18.7% are Spanish); companies that adopt the TCFD recommendations in their NFRs and integrate assurance of GHG emissions in the assurance statement of their NFRs; and companies that adopt the TCFD recommendations but do not mention GHG emissions in the assurance statement of NFRs. Consequently, the companies in this cluster that refer to GHG emissions in their NFRs were analysed, and two main trends emerged. Firstly, the majority of assurance statements (about 71%, of which 43% are Italian and 28% Spanish) perform a limited or reasonable assurance on specific economic, social, and/or environmental GRI indicators or other selected KPIs. The GRI environmental indicators related to climate change are the same as for (cluster b), that is, GRI 302 (Energy), GRI 303 (Water and Effluents), GRI 305 (Emissions), and GRI 306 (Waste). Only one Italian company provides limited assurance on non-GRI KPIs disclosed in the NFRs of 2021 and 2022, such as CO₂ emissions, supply chain carbon footprint, water management, performance of material cycles in manufacturing processes, and new mobility solutions developed.

The second approach adopted in the assurance of NFRs in (cluster c) is the assurance of the GHG emissions inventory, which only occurs in Spanish companies (28.5% of the NFRs). Therefore, assurance activities are undertaken on Scope 1, 2, and 3 of GHG emissions; no reference is made to GRI indicators.

Excluding companies not publishing a TCFD report and do not refer to GHG emissions in NFR, the findings suggest that companies in (cluster c) should be motivated to draw up an independent TCFD report, as they already embrace the TCFD recommendations in their nonfinancial statements. Furthermore, as some of these companies have already integrated carbon assurance into the assurance statements of their NFR, they may develop standalone assurance statements on GHG emissions in the future. Unlike companies in (cluster a), none of the latecomer companies belong to the financial sector; more precisely, the prevalence of these companies is found in sectors different from those in the previous two clusters.

6 | Conclusion

This study explores the dissemination of assurance practices regarding the assurance of GHG emissions over 3 years in a sample of Italian and Spanish-listed companies. A content analysis of the assurance statements in the TCFD reports has been conducted, examining several key characteristics, including the purpose of the assurance, the assurance provider, the standards

applied, the level of assurance, and the conclusions drawn. Concurrently, the NFRs of the sample companies were extracted for 3 years to check the inclusion of assurance on GHG emissions in the overall assurance statement. The analysis reveals that assurance is prevalent in Italian and Spanish sustainability reports; however, assurance on GHG emissions is limited in both TCFD reports and nonfinancial statements of Italian and Spanish companies. Hence, the dissemination of carbon assurance practices among the sample companies has been low over the selected time frame.

Furthermore, this study highlights three different behavioural patterns of companies on GHG emissions assurance: early movers, forthcoming, and latecomers.

Early movers publish and assure the TCFD report. Therefore, they have already consolidated their climate disclosure and carbon assurance practices. It should be noted that the companies included in this cluster are predominantly from the financial sector, particularly banks. Moreover, in the other clusters, there is no presence of companies belonging to this sector, except for one company from the insurance sector in the second cluster (forthcoming).

The marked presence of companies from the financial sector in the first cluster expresses the orientation emerging in this sector in response to the demand for greater disclosure of climate-related information (EC 2019; Friedrich et al. 2023; Lee et al. 2024). More specifically, the increased importance of climate change consequences for businesses has led stakeholders, particularly investors and lenders, to evaluate climate change risks (KPMG 2024a). Banks are increasingly recognising the importance of integrating climate issues into their financial risk management practices (Lee et al. 2024). Hence, there is a need for more reporting and assurance of information on these issues. The other sectors to which the companies in this cluster belong are basic materials, industry and construction, and energy. These sectors are heavily involved in emission reduction initiatives (University of Cambridge and World Energy Council 2014; Tazmeen and Mir 2024), which may explain their greater propensity to use TCFD reporting and assurance. So, this means that organisations can use climate change reporting and assurance to influence how stakeholders perceive the company's image and impacts (Deegan 2002). Legitimacy theory is based on the idea that organisations use assurance to gain stakeholders' support and mitigate pressures imposed by internal and external stakeholders or regulators (Adams 2002).

According to the signalling theory, companies in this cluster may have decided to produce and asseverate the TCFD report as a signal of their commitment to reducing emissions and improving the transparency and credibility of the information disclosed.

The preferred assurance providers for the Italian and Spanish sample companies in this cluster are accounting firms. A predominance of single use of ISAE 3000 (Revised) or ISAE 3410 Standards is observed. Indeed, only a tiny percentage adopts the combination of the two standards. About the level of assurance engagement, a limited level prevails for both Italian and Spanish companies, and a reasonable level is not observed, while their

combination is scarce. Regarding the conclusion the assurance provider gave, both Italian and Spanish companies converge towards the positive form when adopting a reasonable engagement and the negative form with a limited assurance level.

Forthcoming companies publish a TCFD report, but it is not assured. However, a reference to the assurance of GHG information is explicitly provided in the assurance statement of their NFRs and refers to an inventory of GHG emissions or selected GRI indicators disclosed in the NFR. Therefore, it is reasonable to assume that these companies could envisage the assurance of TCFD reports in the future.

Companies in this cluster belong to the same sectors as the previous cluster. This element of substantial homogeneity indicates a strong commitment by companies in the sector to disclosing climate change information. Therefore, through the lens of signalling theory, companies that have made efforts to manage climate change are more willing to disclose climate change information (Cormier et al. 2005; Mahoney et al. 2013). The primary reason a company may avoid the assurance of a report (in this case, a TCFD report) can be attributed to a lack of proper systems to collect precise GHG data or a lack of confidence in the accuracy of that information (Howitt 2025). In this situation, an assurance provider would only confirm these shortcomings.

The last behaviour identified relates to companies that need to be encouraged to report more, that is, latecomers, as they do not publish a standalone TCFD report and independent assurance statement; however, these companies may include assurance on GHG emissions into the statements of their NFRs. In the case of integration of carbon assurance, the results show that assurance can be undertaken in the same way as for forthcoming companies, that is, on the GRI indicators or on the GHG emissions inventory. Still, most Italian and Spanish companies conduct a limited or reasonable assurance on specific GRI environmental indicators or other selected KPIs. Companies in this cluster operate in various sectors, most of which are distinct from those of the previous two clusters.

The behaviour of these companies can be interpreted through the lens of signalling theory as a weak but intentional signal to show some commitment to climate change issues; however, they are not yet ready to take a more visible and structured step (such as a full TCFD report).

The fact that assurance is done on GRI indicators or GHG inventories suggests that the company selects targeted signals, perhaps to satisfy specific stakeholders (e.g., investors) or to test the market's reaction. From a legitimacy standpoint, this limited recourse to climate change reporting and assurance can be interpreted as an initial, albeit partial, response to emerging regulatory pressures (e.g., the Corporate Sustainability Reporting Directive-CSRD) and social expectations.

As a result, the findings of this study suggest that the assurance of GHG emissions is currently an emerging and underdeveloped issue among Italian and Spanish companies; thus, carbon assurance practices are limited but more widespread among companies in the financial sector. Indeed, few companies in the Italian and Spanish samples engage in TCFD reporting and assurance

of GHG emissions. These results are consistent with the predictions of signalling theory, which focuses on the role of disclosing the information as a positive signal to demonstrate commitment to voluntary activities, and of legitimacy theory. Applying this perspective to the reporting and assurance of carbon emissions reports, we argue and present evidence that having carbon emissions assured by an external provider, in particular for companies of the financial sectors, can be an effective way to signal to stakeholders the commitment regarding the management of carbon issues and the transparency and credibility of their carbon activities, thereby gaining stakeholder support and legitimacy. For forthcoming and latecomer companies, the limited reference to climate change issues in the assurance statements of NFR may be a strategic way to convey environmental commitment to stakeholders. This approach can be interpreted as a response to emerging normative pressures, allowing companies to maintain social acceptance while avoiding a full commitment to a comprehensive sustainability reporting framework.

This study contributes to the research on carbon assurance by outlining current assurance practices on GHG emissions within a sample of Italian and Spanish listed companies. The findings emphasise the need to improve carbon assurance practices, also in light of the latest sustainability standards and regulatory developments, which may prompt companies to focus their attention on climate impact reduction strategies and emissions reporting.

The CSRD mandates that European companies within its scope obtain external assurance for their sustainability information (EC 2022). Moreover, the European Sustainability Reporting Standards (ESRS) and the EU Taxonomy Regulation require companies to report on their environmental sustainability, particularly regarding climate change mitigation and adaptation (EC 2020). The ESRS E1 standard provides detailed guidance on climate-related disclosures (EFRAG 2022), while the IFRS S2 standard, issued by the ISSB (IFRS 2023) focuses on climate risks and opportunities across governance, strategy, risk management, and metrics. Together, these frameworks underscore the growing importance of credible, assured climate reporting in corporate sustainability.

Considering that, to date, there is no snapshot of how Italian and Spanish companies are reporting and assuring climate change information, this provides a benchmark to assess the evolution of this topic.

The study's implications are significant for firms, assurance service providers, regulators, and report users. Indeed, the need to increase the credibility and reliability of reporting on emissions (possible through assurance) is growing in line with the European Union's strategy to achieve a climate-neutral society and the containment and reporting objectives of emission reduction actions that strongly involve companies. Furthermore, carbon assurance may be a significant driver in investors' decisions when assessing companies' creditworthiness (Safiullah et al. 2025).

This study has some limitations. Indeed, the number of companies that assure their TCFD report and include a reference to

GHG emissions in the assurance statement of the NFR is quite limited; thus, expanding the sample to other companies and countries may provide more meaningful results. The analysis does not allow for a complete understanding of the reasons for producing and assuring TCFD reports or disclosing and assuring climate change information in the sustainability reports. However, these limitations can be the starting point for future research avenues.

Future research could extend the sample to companies in other European and non-European countries. It will be interesting to monitor the development of new assurance standards and practices. Some changes are underway and related to the recent approval of the ISSA 5000 and the future development of assurance standards at the European level, as required by the CSRD (EC 2022). Furthermore, future studies could conduct interviews or submit questionnaires to company members and/or assurance providers to understand the reasons behind different approaches to assurance (i.e., the decision to assure or not assure, the choice between accounting or nonaccounting assurance providers or the level of assurance) and the advantages and limitations of using assurance. Moreover, it may be interesting to know why companies that adopt the TCFD recommendations in their sustainability reports do not publish a standalone TCFD report.

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