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How Environmental Assurances and Certifications Shape Environmental Scores and Their Relationship with Environmental Controversies: Evidence from the Main European Union Companies

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Abstract

This study examines whether environmental assurance and environmental management certifications are associated with subsequent environmental performance and reputational exposure in European Union listed firms. Using Refinitiv Eikon panel data for 441 firms (1773 firm-year observations) from 2017–2023, we analyze environmental pillar sub-scores (Emissions, Resource Use, and Innovation) and three intensity indicators (energy, pollution, and recycled waste intensity). We estimate firm fixed-effects models for performance outcomes and Firth's logistic regression models for media-reported environmental controversies, using lagged assurance/certification indicators. Environmental assurance is consistently associated with higher environmental sub-scores and with lower energy and pollution intensity, alongside higher recycled waste intensity. In contrast, certification effects are weaker and more heterogeneous across intensity-based indicators. Regarding reputational exposure, assured firms show a higher likelihood of subsequent media-reported environmental controversies, which is consistent with heightened scrutiny and visibility rather than evidence of intent. These findings inform boards, assurance providers, investors, and policymakers seeking to strengthen the credibility and use of corporate environmental information.

Keywords: environmental assurance; environmental management certifications; environmental performance; environmental intensity; environmental controversies; European Union listed firms

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1. Introduction

In recent years, environmental sustainability has become increasingly important in business strategy, especially within the European Union. Regulatory frameworks surrounding sustainable environmental management have gradually become stricter, while at the same time the expectations of various stakeholders and institutional regulators have grown [1–3]. In this context, environmental assurances and certifications such as ISO 14001/14064 [4,5] and the Eco-Management and Audit Scheme (EMAS [6]) would act as instruments that promote more responsible environmental management, encouraging companies to reduce their ecological footprint through continuous improvement processes [4,6–8].

Environmental performance, from an enterprise perspective, refers to the extent to which firms manage and reduce environmental impacts while maintaining output and financial viability. In practice, companies operationalize environmental performance through internal management controls and process improvements that target eco-efficiency (e.g., energy use and emissions per unit of activity), compliance and risk management, and circularity outcomes (e.g., waste recovery and recycling). These dimensions often involve measurement systems, data governance, and continuous-improvement routines, and they can display short-run trade-offs during investment and transition periods, particularly when performance is expressed as intensity ratios relative to revenue [9–11]. This enterprise-oriented view motivates our combined use of Refinitiv environmental sub-scores and intensity indicators to capture both perceived performance (scores) and performance relative to economic output (intensities). Environmental auditing serves as a vital tool for assessing corporate ecological impact and ensuring regulatory compliance. By identifying operational risks, it enables organizations to integrate sustainable strategies and enhance resource efficiency.

There are three major theories widely used in accounting, management, corporate governance, and sustainability research. They help explain why organizations behave the way they do, especially in terms of disclosure, reporting, and stakeholder engagement: Stakeholders [12], Legitimacy [13], and Institutional [14]. In the context of strategic management Resource-Based View (RBV) offers a solid theoretical framework for understanding how companies leverage their internal capabilities to achieve competitive advantage through sustainable innovation [15]. Complementarily, Signalling theory reinforces RBV by explaining how companies communicate their environmental commitments and innovations to external stakeholders, thereby building legitimacy and trust. Environmental assurances and certifications would function as credible signals that convey the company's environmental responsibility and its efforts towards continuous improvement, key elements in highly competitive markets where stakeholder scrutiny is intense [8,16].

Environmental regulation also plays a key role in shaping corporate sustainability strategies. The evolution of the European Union's regulatory framework, from the Non-Financial Reporting Directive (NFRD) to the more comprehensive Corporate Sustainability Reporting Directive (CSRD), illustrates the growing institutionalization of sustainability reporting requirements [2]. The CSRD introduces a phased implementation of expanded sustainability reporting requirements, with the first wave applying for financial years starting on or after 1 January 2024, and it strengthens the role of external assurance over reported sustainability information [2]. These regulatory mandates broaden the scope of disclosure obligations, improving comparability, accountability and stakeholder confidence in reported environmental claims. However, the risk of greenwashing, when companies portray a greener image than their actual practices justify, has drawn academic attention to the rigour and scope of financial-audit approaches when applied to non-financial reporting and sustainability assurances. Maroun [17] acknowledges that auditing plays a crucial role in enhancing the quality of non-financial reporting; however, the inconsistency of reporting formats may facilitate practices associated with greenwashing. Innovations in audit methodologies, including the integration of artificial intelligence and machine learning tools, offer promising avenues for improving the detection and prevention of greenwashing practices, thereby strengthening the credibility of sustainability reporting [18].

While greenwashing remains a concern, empirical evidence offers limited support for its widespread presence. ESG scores show little adjustment after corporate scandals and remain stable when non-financial data is externally audited, suggesting greater reliability [19]. Furthermore, meta-analytic evidence highlights the positive impact of ISO 14001 [4] and EMAS [6] on environmental performance, particularly when management systems are internalized, indicating that certification cannot be reduced to mere greenwashing [7].

Consequently, this study addresses two related research questions in EU listed firms over 2017–2023. First, using fixed-effects models, we examine whether environmental assurance engagements and environmental management certifications are associated with subsequent environmental performance, captured by Refinitiv environmental pillar sub-scores (Emissions, Resource Use, and Innovation) and intensity indicators (energy, pollution, and recycled waste intensity). Second, using Firth's logistic regression models, we examine whether assurance and certifications are associated with the likelihood of next-year media-reported environmental controversies. We treat controversies as an observable proxy for reputational exposure and external scrutiny (i.e., negative environmental publicity), rather than as a direct measure of misleading environmental claims or managerial intent. This framing allows us to test whether credibility-enhancing mechanisms (assurance/certification) are associated with subsequent performance outcomes and controversy exposure, while avoiding inferences about opportunistic behaviour.

The rest of the article is structured as follows. Section 2 reviews the main economic theories that explain the relationship between environmental sustainability and corporate strategy, and the development of hypotheses. Section 3 presents the research methodology. Section 4 outlines the results. Section 5 shows the discussion. Section 6 displays the conclusions.

2. Theoretical Background and Hypotheses Development

2.1. Conceptual Framework

In the literature review, we found three main complementary approaches. To make these complementary perspectives explicit and to highlight the resulting research gap, Table 1 summarizes the core mechanism each theory proposes, how it links assurance/certifications to environmental performance, and how it may relate to next-year media-reported environmental controversies (interpreted as reputational exposure/scrutiny).

Table 1. Complementary theoretical approaches and resulting research gap.

Theories	Mechanism	Assurance/ Certifications Role	Performance Link	Controversies Link (Reputational Exposure)	Gap
Stakeholder	Stakeholder pressure and information demands	Credibility/ comparability; reduces information asymmetry	Expected+	Ambiguous: credibility vs. more visibility/scrutiny	Joint evidence on performance + controversies is limited
Legitimacy	Social acceptance; symbolic vs. substantive actions	Can be substantive improvement or symbolic legitimation	+ if substantive; heterogeneous if symbolic	Potentially + via scrutiny/attention	Limited panel evidence linking assurance/certs to next-year controversies
Institutional	Coercive/ mimetic/ normative pressures	Adoption driven by regulation/standards; not always substantive	+ but uneven across indicators	Possibly + via monitoring/ visibility	Few EU-context studies testing lagged effects on both outcomes

Taken together, these theories suggest that assurance and certifications are generally expected to be associated with subsequent improvements in environmental performance, although effects may be heterogeneous across intensity-based indicators. At the same time, the relationship with subsequent media-reported environmental controversies is theoretically ambiguous: external verification can either mitigate reputational risk by strengthening credibility or increase reputational exposure by raising visibility and scrutiny. Building on this synthesis, we derive the hypotheses tested in Section 2.4.

First, stakeholder theory recalls that value is built with multiple stakeholders [12] and therefore, companies resort to external assurance and standards/certifications to respond to information demands and align expectations. Second, legitimacy theory suggests that companies seek social approval [13], independent verification and frameworks such as ISO 14001/14064 and the Global Reporting Initiative (GRI) Standards [20] serve as legitimising mechanisms and credible signals of commitment. Finally, according to institutional theory, companies adopt assurance and standards because they are pressured by regulators, imitate industry leaders and follow professional norms, thus they end up resembling each other in their practices [14]. In addition, we draw on RBV and signalling perspectives to motivate the performance channel, while the EU regulatory context motivates institutional pressures for assurance and certification.

Although reporting quality has improved, environmental performance does not always keep pace [9], and investors continue to demand comparable and verifiable data [21,22]. Reporting guidelines and external checks help strengthen the quality of the information. When organizations follow established standards, they share more useful details. Also, verification that focuses on the actual content is more credible and thorough than verification that only reviews the process [23]. Rigorous audits under greater media scrutiny are associated with more transparency and higher ratings when ESG is audited with high quality [24,25]. Moreover, in the aftermath of scandals, externally assured reports sustain ESG scores better, suggesting more reliable underlying metrics [19].

Currently, more specifical theoretical frameworks on strategic management highlight the importance of companies' resources, capabilities, and external pressures, which shape competitive advantages, particularly in the context of green innovation and corporate social responsibility. Focusing on RBV, Khanra et al. [26] explore the concept of green innovation through a bibliometric analysis, revealing its significant growth as a strategic resource for companies. Along the same lines, McGahan [11] acknowledges that dynamic capabilities and resource reallocation, i.e., the process of shifting resources towards more sustainable initiatives, may not yield immediate returns but are crucial for addressing global challenges and respecting the wishes of stakeholders.

Some authors emphasise the importance of the RBV as a basis for understanding how companies manage their assets. Henri [15] sets out the fundamental premise of this theory: companies manage valuable and inimitable organisational capabilities in order to achieve strategic differentiation. This is in line with the view that control of heterogeneous resources enables companies to survive and develop in an environment full of uncertainties [27]. However, Priem and Butler [28] critically note that the classic formulation of RBV assumes static market conditions and a lack of rigour in the valuation of resources, calling for new, more dynamic and causal models that improve its explanatory power in strategic management.

At the same time, signalling theory emerges as a complementary framework that explains how companies communicate environmental commitments and innovations to stakeholders. Bergh et al. [29] illustrate the usefulness of this theory in interpreting the strategic information provided by companies as unobservable signals of their capabilities or those of their managers. Todaro et al. [16] specifically highlight its relevance in environmental management systems, where certifications serve as credible signals, increasing legitimacy and stakeholder confidence. Signalling theory agrees with RBV in recognising how internal business capabilities must be adequately communicated in order to achieve competitive advantages.

Environmental regulation is another vital theoretical pillar that undoubtedly influences corporate strategies. Liu et al. [30] demonstrate that regulatory pressure forces the most polluting companies towards greater green innovation. In this context, Aragón-Correa et al. [31] point out that environmental regulation is a powerful institutional force that influences innovation activities within a sector. Furthermore, regulations contribute to the convergence of patented technologies, as companies tend to develop environmental innovations in the same technological fields. Khanra et al. [26] recognise regulatory compliance as a strategic resource, reflecting the dual role of regulation in modifying corporate behaviour and innovation trajectories.

Finally, we can consider the theory of innovation, where Corporate Social Responsibility (CSR) acts as a strategic resource that enhances companies' capacity for innovation and improves sustainability results. Gallego Álvarez et al. [32] use this theory to link CSR (which is not simply a cost or an ethical obligation, but a strategic investment by the company that contributes to greater competitiveness and value creation) to innovation capabilities via the RBV. Khanra et al. [26] identify organisational learning and knowledge accumulation as critical enablers of sustainable green innovation.

2.2. Regulations and Standards

In recent decades, the European Union has focused on transforming its economy with the aim of making it more efficient, environmentally friendly and fair. This has been demonstrated, among other things, by the protection of biodiversity by 2030 and the goal of climate neutrality by 2050. To this end, an increasingly demanding regulatory framework has been developed, determining the sustainability information that companies must disclose, as well as the scope, quality and reliability of such information.

The first step in this direction came with the adoption of Directive 2014/95/EU [1], which required public-interest entities to report on certain environmental, social and governance aspects. Although this was a first step, the expected objective was not achieved due to the breadth and flexibility of its requirements. Reports varied greatly in terms of quality and scope [1]. In order to address these limitations, enhance transparency and credibility, and improve comparability between sectors and countries, Directive (EU) 2022/2464 [2], known as the Corporate Sustainability Reporting Directive (CSRD), was adopted. The application of this Directive, in compliance with the European Sustainability Reporting Standards [3], is based on the principle of double materiality, which requires reporting on both the sustainability risks to the company itself and the impacts of its activities on society and the environment.

As a direct consequence of the implementation of the CSRD's scope of application, the number of European companies that will be required to submit standardised information from 2024 onwards will increase from 11,700 to around 49,000. This includes both large companies and SMEs that are listed on the stock exchange [2]. Another significant change is the requirement for sustainability reports to undergo independent external assurance. The CSRD stipulates that these reports must initially be subject to limited assurance by a statutory auditor or an accredited verifier, although it is expected to gradually evolve towards reasonable assurance in the future, with a deadline of 1 October 2028 [2].

On the other hand, the European Union maintains voluntary regulations, such as Regulation (EC) No. 1221/2009 on the Eco-Management and Audit Scheme [6]. EMAS aims to improve the environmental performance of entities through external audits and the publication of verified statements. In this regard, certifications from the International Organization for Standardization (ISO), such as ISO 14001 (environmental management) and ISO 14064 (carbon footprint), as well as the European Ecolabel, reinforce the legitimacy of business practices by being backed by internationally recognised verification processes [4].

All of this shows the evolution, from a regulatory point of view, of the information provided by companies on corporate sustainability in Europe. Starting initially from a voluntary approach, progress has been made towards a regulated system, in which standardisation and independent assurance have become fundamental elements of corporate accountability.

2.3. Greenwashing

Some authors point to a growing tension between ESG indicators and the reality behind them. Lee and Raschke [33] reveal that companies with high ESG indicators could cause uncertainty because their current procedures do not match the expectations of the stakeholders involved. However, this does not occur when these companies go beyond superficial objectives and implement circular economy principles. In the same vein, Kathan et al. [34] warn that ESG indicators could be misleading, reflecting superfluous information rather than genuine environmental improvements, creating a fictitious reality that could mislead stakeholders.

The detection of possible greenwashing has become a very important topic among researchers. Lagasio [18] recommends the use of machine learning when analyzing generic environmental reports. Similarly, Gorovaia and Makrominas [35] propose the use of AI tools to detect inconsistencies between words and actions. These approaches show a shift from a more content-based analysis to one of greater rigor. Lagasio and Cucari [36] highlight the importance of having increasingly specific indicators to try to avoid increasingly sophisticated greenwashing techniques.

The complex relationship between regulation, environmental reporting, and greenwashing is also a subject of debate in scientific doctrine. Zhang [37] argues that greenwashing could erode a company's reputation, reducing consumer satisfaction and trust. Esposito et al. [38] adds that companies that allocate resources to renewable energy or green investment initiatives due to pressure from their stakeholders could be deviating from their current economic and ESG objectives, inadvertently leading them toward greenwashing. Todaro and Torrelli [39] describe ESG-washing as an evolution beyond purely environmental toward the social and corporate, especially when companies embark on circular economy projects that prioritize image over substance.

Finally, business communication tools and stakeholder involvement are important in minimizing greenwashing. Lee and Raschke [33] recognize that companies that use sophisticated vocabulary may be trying to hide weak environmental performance. Treepongkaruna et al. [40] acknowledge that entities with high ESG indicators may have less incentive to reduce their polluting emissions. Clements [41] points out that the inconsistency of ESG metrics and poor comparability between companies, could undermine the ability of stakeholders and regulators to distinguish real actions from greenwashing.

2.4. Hypotheses Development

We now develop testable hypotheses linking assurance/certification to subsequent performance outcomes and to the likelihood of next-year media-reported environmental controversies.

Organizations seek external assurance to legitimize and signal their sustainability performance to external audiences. Dutta [8], in a study of 176 firm-year observations covering an 8-year period (2008–2015) for 22 listed Finnish companies that have issued sustainability verified reports during the sample period highlights that firms engaged in environmental auditing tend to enhance the reliability of ESG disclosures, effectively reducing information asymmetry between firms and stakeholders. Darnall et al. [23], in a work with Japanese firms, document that adherence to ESG reporting guidelines correlates with firms' propensity to seek more robust third-party verification of sustainability reports. Their empirical evidence suggests that content-focused environmental verification, not merely process-focused one, drives richer environmental disclosures, reinforcing the value of environmental auditing in ESG reporting. Baraibar-Diez and Odriozola [42], in his study of companies in four European countries, examine the relationship of CSR committees on environmental performance. According to the authors, having such a committee has a positive influence on ESG indicators.

Gan et al. [43], from a data-panel of A-share listed companies in China between 2009 and 2021, examine the association of environmental auditing on corporate ESG performance, finding that environmental assurance is positively associated with ESG outcomes by making "post-event accountability" effective. The positive effects are particularly pronounced in state-owned and small-scale enterprises, highlighting the significant role of environmental auditing in improving corporate environmental responsibility and governance. Giudice and Rigamonti [19] report in their analysis of 71 scandals in 54 companies for the period 2007–2017 that companies with audited non-financial reports do not suffer significant changes in their scores and that; therefore, environmental auditing acts as a confidence booster in the quality of ESG information. Abay [44] examines the role of independent third-party assurance in environmental, social, and governance (ESG) as a signal of better performance. Using linear regression on data from 645 European firms between 2012 and 2017, the author finds that companies with external assurance show significantly higher ESG performance. The results highlight the value of such assurance as a signalling mechanism to differentiate high-performing from low-performing firms. Arena et al. [45] examine the association of sustainability reporting standards and external assurance on ESG rating disagreement among STOXX Europe 600 and S&P 500 firms. The authors find that adopting reporting standards does not significantly reduce ESG rating divergence, whereas external assurance practices notably decrease disagreement. The findings emphasize the importance of assurance in enhancing the reliability and comparability of sustainability information used by rating agencies (Figure 1) .

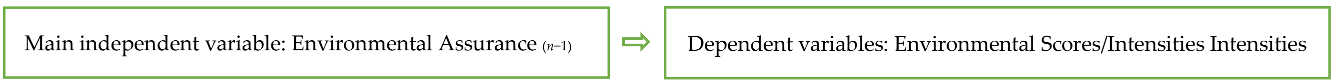

Figure 1. Research Framework H1+.

Based on this evidence, we propose:

Hypothesis 1. *Firms undergoing environmental assurance the previous year achieve better environmental scores (Refinitiv environmental scores and intensities).*

The main theory that could explain the link between Environmental Management Systems (EMS), particularly ISO 14001, and green innovation is the Resource-Based View (RBV). This theory suggests that certifications help companies manage their resources more efficiently, which would guarantee the development of technological innovations, and encourage them to align their policies with environmental objectives [46,47]. Furthermore, signalling theory would support the role of ISO 14001 as a credible signal to the market for the implementation of new technologies, mainly in entities with limited innovative capacity [48].

The integration of environmental management models with internal company procedures, through the PDCA (Plan-Do-Check-Act) cycle integrated into ISO 14001, promotes technological updating and sustainable orientation that are embedded in innovation strategies, leading to the development of new products and processes that improve environmental performance and competitiveness [49,50]. Similarly, Iraldo et al. [51] point out that environmental certifications such as EMAS not only produce improvements in environmental indicators but also lead to new competitive advantages.

In the same way, Testa et al. [52] highlight the new sustainable environment that is created after certification, which promotes innovation through the redesign of processes and products. This process encourages entities to increase their investment in R&D with the goal of reducing their environmental impact and improving business performance. For instance, in their qualitative methodological study on the assessment of organisations registered under ISO 9001 [53] through interviews with R&D directors, authors Jayawarna and Pearson [54] illustrate how certification can influence R&D through its role as a strategic control tool, as a project and process manager, as a facilitator of employee development, and as a corporate culture of continuous improvement. Finally, Wagner [55] finds that companies that adopt environmental management systems such as ISO 14001 show higher levels of innovation as measured by their patent registrations. The various certifications facilitate the implementation of environmental goals in R&D processes, thereby strengthening the relationship between certifications and technological innovation.

However, Environmental Management Systems (EMS) are voluntary codes of business conduct that seek to manage and respond to the environmental impacts of companies. ISO 14001 and EMAS are the most important EMS's, the former at the international level and the latter in Europe. Although both frameworks basically share the same structures in terms of environmental policies, objective settings, implementation of processes and evaluation of indicators, EMAS requires a higher level of transparency through the requirement of an annual external environmental audit. According to Heras-Saizarbitoria et al. [56], the conceptual support for EMS's rests on a cycle of continuous improvement that requires the integration of international environmental practices into the corporate culture of each entity to obtain tangible results, although the author complains that certifications may focus more on procedural and documentation issues than on genuine substantive improvements.

In a cross-sectional study of 4292 companies from Europe, East Asia, and North America, Ronalter et al. [57] show that companies with EMS (ISO 14001) and/or QMS (Quality Management System) obtain significantly higher values in the Environmental Pillar Score than non-certified companies. With 583 companies in 46 countries, Arocena et al. [58] find that ISO 14001 reduces CO_2 intensity and raises profitability, moderated by size and country environmental awareness. In the same way, Ofori et al. [59] in their study of European countries for the period 2002–2017 on the implementation of ISO 14001 find that ISO 14001 certification is generally associated with a significant reduction in CO_2 emissions.

Qi et al. [60] in their work based on a survey of 246 construction companies in China show that internalisation of the standard mediates the relationship between ISO 14001 and environmental performance: when EMS is integrated into firm routines and beliefs, the results are superior. However, in a panel of 1214 manufacturing companies from 7 OECD countries, Ferrón-Vílchez [61] shows that superficial or symbolic environmental actions don't lead to the same improvements. Real environmental progress and better profitability only happen when companies carry out thorough impact monitoring, not when they make cosmetic changes.

The effectiveness of EMS's implementation and its impact can also be moderated by sectoral and contextual factors. Companies operating in highly polluting sectors are more likely to reap greater benefits from implementing these types of processes than those operating in other sectors, where the motivation may be more symbolic or reputational [10]. The great heterogeneity of companies underscores the importance of managing sectoral and company-specific factors such as regulatory frameworks, shareholder pressures and company size when assessing the effectiveness of EMS's implementation [62].

Methodologically, much of the existing literature relies on management perceptions of environmental improvements following the adoption of an EMS's. Daddi et al. [10] criticize this approach, calling for future research to integrate actual data such as emissions levels and energy consumption for a more accurate assessment. Although Tourais and Videira [63] acknowledge that the relationship between the implementation of EMAS and its environmental performance still yields contradictory data, the authors point out that EMAS seems to have a positive influence on organisational performance, as it promotes the development of intangibles. In the same vein, Marrucci and Daddi [64] in their study about 268 environmental statements of Italian manufacturing firms show a slight deterioration in some organisations' environmental performance indicators after the implementation of an EMAS (Figure 2).

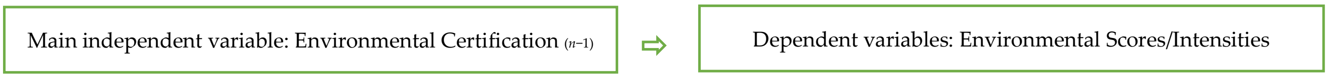

Figure 2. Research Framework H2+.

Based on the foregoing, we propose:

Hypothesis 2. *Firms undergoing certification processes the previous year exhibit superior performance on environmental indicators (Refinitiv environmental scores and intensities).*

The phenomenon of greenwashing, where companies try to appear more sustainable than they actually are, has attracted a lot of attention particularly in the context of EMS's. Frendy et al. [65] analyze a sample of 420 firm-year observations from Japanese listed companies covering the period 2018–2019 that responded to the CDP Climate Change survey via probit/logit and multivariate panel data regression models, finding that environmental assurance carries a significant risk of being exploited by companies involved in greenwashing to increase the degree of their overstatement.

The quality and scope of external environmental audits are essential for the verification of the effectiveness of EMS's and the detection of possible greenwashing behaviour. Maroun [17] agrees that the audit function is necessary to improve the quality of non-financial reporting, but the variability of formats could help promote greenwashing practices. Issa [66] adds that the establishment of sustainability committees within firms, involving both internal and external auditors, can help mitigate ESG-related controversies and reinforce sustainable business practices.

Some authors point out that internal audits or audits conducted without sufficient independence, along with commercial pressures, may lack the necessary robustness to generate environmental improvements or credible reports, considerably heighten the risk of greenwashing practices despite regulatory advances [67,68]. Battisti et al. [69] highlight the critical importance of incorporating multidisciplinary expertise, including auditors, engineers, and environmental scientists, into assurance teams to enhance the credibility and effectiveness of sustainability assurance.

However, environmental assurance could inhibit corporate greenwashing by enhancing the authenticity of environmental disclosures, regulate management practices by reducing the frequency of violations, and strengthen public supervision, prompting greater media attention to environmental performance [43]. Jámbor and Zanócz [70], in their systematic review, posit that one of the possible solutions to greenwashing could be the standardisation of ESG indicators and improved control through independent assurance and audit processes.

Regarding incentives, studies in China indicate that greenwashing can improve short-term financial performance, but the effect weakens or reverses when environmental regulation is stringent or media coverage is unfavorable [71,72]. In other words, where information asymmetries persist and oversight is weak, cosmetic disclosure pays off; however, under stronger scrutiny it is penalized.

Although concerns about greenwashing persist, part of the empirical evidence does not support its generalized validation. It has been observed that, following the disclosure of corporate scandals, ESG scores do not exhibit significant average adjustments; moreover, when non-financial information is externally audited, those scores do not deteriorate, suggesting greater reliability of the information and offering little support for the hypothesis of widespread greenwashing [19].

Focusing on environmental certifications, companies may try to legitimize themselves by making symbolic use of them [73]. Content analysis of third-party verified statements from EMAS-registered organizations in Spain shows weak improvements and even deterioration in indicators, alongside vague justifications, suggesting that certification may operate more as a ritual of legitimacy than as substantive change, a pattern compatible with greenwashing [73]. According to Yang et al. [74] greenwashing is frequent, erodes trust, and harms consumers and investors, especially where regulation is lax and competitive pressure is low.

However, Erauskin-Tolosa et al. [7] find a positive effect of ISO 14001 and EMAS on environmental performance and emphasizes that the internalization of management systems enhances this effect, indicating that certification, in aggregate terms, cannot be classified merely as greenwashing. While this study does not explicitly test for the presence of greenwashing, the extensive literature on the subject provides a critical theoretical foundation for hypotheses (Figures 3 and 4).

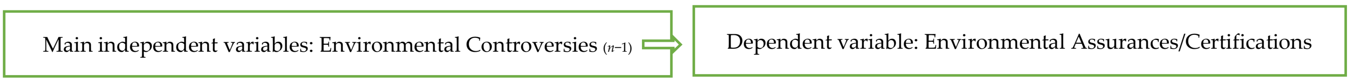

Figure 3. Research Framework H3.1+.

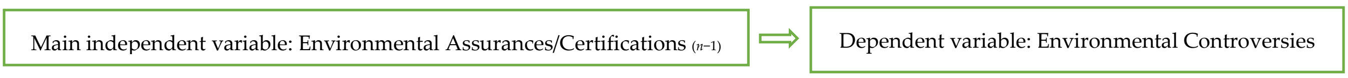

Figure 4. Research Framework H3.2.1−/H3.2.2+.

Based on the above, we propose:

Hypothesis 3.1. *Firms that have controversies are more likely to audit their environmental performance or undergo certification in the following period.*

And two competing hypotheses:

Hypothesis 3.2.1. *Firms relying on environmental assurance and/or certifications face a lower likelihood of next-period media-reported environmental controversies or,*

Hypothesis 3.2.2. *Firms relying on environmental assurance and/or certifications face a higher likelihood of next-period media-reported environmental controversies.*

3. Research Methodology

3.1. Data and Sample

Our sample comprises 441 EU-listed firms, yielding 1773 firm-year observations over the period 2017–2023. Data were sourced from the Refinitiv Eikon database [75], with selection criteria designed to enhance reliability and comparability. In line with Directive (EU) 2023/2775 [76] (amending Directive 2013/34/EU [77]), only firms with audited financial statements and minimum thresholds of €12 million in revenue and €6 million in total assets were included. These filters ensured the exclusion of micro-entities and guaranteed a baseline of financial materiality, thereby strengthening the robustness of the dataset. We use Refinitiv Eikon because it provides standardized, cross-country comparable ESG scores for EU-listed firms, including environmental pillar sub-scores, intensity-based indicators, assurance/certification fields, and media-reported environmental controversies, enabling a consistent multi-country panel design over 2017–2023. As with any commercial ESG database, coverage and measurement choices are provider-defined; we therefore rely on Refinitiv's published methodology and report score definitions transparently (Section 3.2; Table 2).

Table 2. Characteristics of variables.

MAIN VARIABLES	
Environmental assurance	External verification of environmental data is the process performed by an external auditor to confirm the accuracy and validity of the environmental performance metrics the company discloses. Count it as verified if the company's operational environmental data is being checked by an independent external auditor.
Certification 1. None 2. ISO 3. EMS 4. Both	Information qualifies if at least one of the company's individual sites holds ISO 14001/14064 certification, EMS or Both. Simply stating adherence to ISO 14001 requirements (without third-party certification) or following internal environmental management policies does not qualify; formal ISO 14001 and/or ISO 14064 certification is required
Certification Yes/No	If the firm has undergone some certification over the period.
Controversies Yes/No	If the firm has some controversy over the period
Environmental	Environmental Score (0–100)
Emissions	Emission Score (0–100)
Resources use	Use of Resources Score (0–100)
Innovation	Environmental Innovation Score (0–100)
Energy Intensity	Natural logarithm of Total Energy Consumption (in MWh)/Total Revenue
Pollution Intensity	Natural logarithm of Total Pollution (tons of CO_2)/Total Revenue (Scopes 1 and 2)
Waste Intensity	Total Recycled Waste (tons)/Total Waster Generate (tons)
CONTROL VARIABLES	
Leverage	Leverage = Total Liabilities/Market Capitalization
Full Time Employees	Natural logarithm of the total number of employees
ROA	ROA = EBIT/Total Assets
Independent Board Members	Fraction of the number of independent members on the Board (0–1)
Board Structure Type	Categorical variable based on the structure of the board: 1. Unitary. 2. Two Tier Oversight. 3. Mixed.
Country	Country of the firm.
Sector	Sector of the firm.

3.2. Variables and Measurement

This study uses panel data from Refinitiv Eikon rather than survey or questionnaire-based measures. *Environmental assurance* $_{(n-1)}$ is a binary indicator capturing whether the firm discloses external verification/assurance of its environmental figures in the previous year. *Environmental management certification* $_{(n-1)}$ captures whether the firm reports recognized environmental management certifications and is modeled as (i) a four-category variable (no certification; ISO; other EMS scheme such as EMAS; both ISO and EMS) and, where required, (ii) a binary indicator (*Certification Y/N*). In our study, the fundamental independent parameters *Environmental Assurance* $_{(n-1)}$ [8,19,44,45] and *Certification* $_{(n-1)}$ [7,10,59,73] are included with one-year lag to mitigate potential reverse endogeneity.

To capture reputational exposure, we use Refinitiv's media-reported environmental controversies indicator (*Controversies*), which reflects negative environmental publicity rather than legally verified misleading environmental claims. We therefore interpret this outcome as reputational exposure/scrutiny rather than intent.

Environmental performance outcomes are captured using Refinitiv's environmental pillar sub-scores (*Emissions*, *Resource Use*, and *Innovation*; 0–100) and three intensity indicators: *Energy intensity* (log of total energy consumption divided by total revenue), *Pollution intensity* (log of total CO_2 emissions divided by total revenue; Scopes 1 and 2), and *Waste intensity* (recycled waste divided by total waste generated; 0–1). The indicators provided by Eikon would be highly reliable; for example, according to Busch et al. [78] the correlation between pollution intensity and the indicator provided by Disclosure Carbon Project would be around 94%.

The model also includes the following firm-level controls: *Leverage*, a proxy for financial risk [43]; *Full Time Employees* to control for firm size, measured as the natural log of full-time employees [46,52,64]; *ROA* as a measurement of profitability [43]. To account for internal governance mechanisms, we include *Independent Board Members* measured as the fraction of independent directors [65] and *Board Structure Type*, captured with a categorical variable for two-tier and mixed systems [42], using the one-tier system as the reference category, as these factors significantly influence monitoring effectiveness and strategic decision-making regarding environmental performance. Table 2 presents the definitions, summary characteristics, and references for all variables included in the model.

3.3. Descriptive Statistics

Table 3 presents the main descriptive statistics for the continuous variables used in our analysis. We can highlight the high averages in the environmental scores of the companies in our sample, although there is a large dispersion in the *Waste Intensity* rate (0.24). As for the rest of the variables of control, the average *ROA* would be around 7% and the companies would have a board made up of almost 60% independent members, although this last variable would also have a high dispersion (0.24).

Figure 5 shows that external assurance remains rare (29% of observations), while environmental management certifications are more common (Figure 6). In other words, companies are more likely to certify their management systems than to submit their environmental data to independent verification. 3.5% of the total observations show at least one controversy (Figure 7). As shown in Figure 8, the board design in the sample is concentrated in two groups: approximately three-fifths of the firm-year observations are unitary and about one-third are two-level, while mixed structures are rare (<5%).

Table 4 shows that France (339), Germany (263) and Sweden (209) provide the highest number of observations. Hungary (12), Czech Republic (5) and Romania (3) have the lowest number of observations. Overall, there are 1773 company-year observations corresponding to 441 unique companies, distributed across nine sectors. Sector intensity is highest in Industrials and Consumer Cyclicals and lowest in Energy and Real Estate.

Table 3. Descriptives of continuous variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
Environmental	1773	72.14	15.77	15.89	99.14
Emissions	1773	78.42	17.34	18.21	99.84
Resources use	1773	79.08	19.05	0.16	99.90
Innovation	1773	56.99	24.91	0.75	99.90
Energy Intensity	1773	6.16	1.73	−3.21	14.68
Pollution Intensity	1773	6.38	1.36	2.08	10.53
Waste Intensity	1773	0.70	0.24	0.00	1
Leverage	1773	1.68	2.81	0.02	47.61
Full Time Employees	1773	8.93	2.07	0.00	13.41
ROA	1773	0.07	0.05	0.141	0.43
Independent Board Members	1773	0.59	0.24	0	1

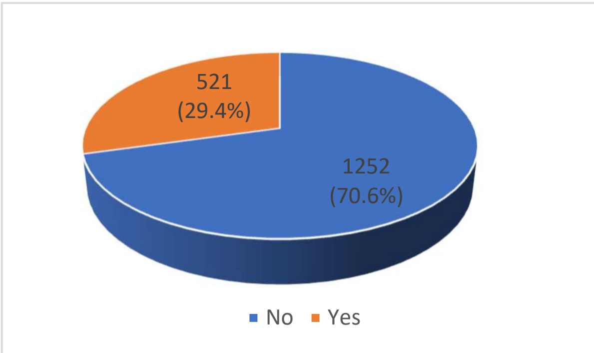

Figure 5. Environmental Assurance distribution.

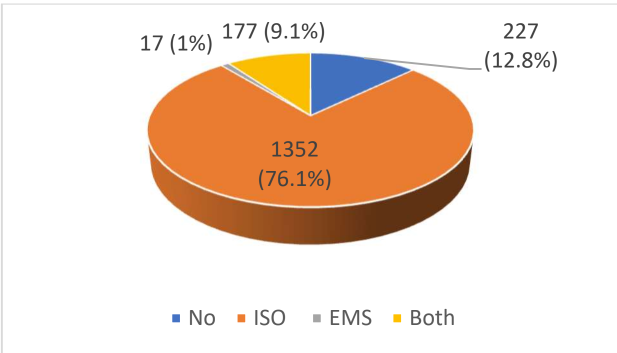

Figure 6. Certifications distribution.

Table 5 presents the bivariate correlations between variables to test for dataset multicollinearity. Results confirm that collinearity does not pose a problem as VIF values are less than 2.5, and tolerance indexes are over 0.40 for all variables. In general, the associations are moderate or low, which reduces concerns about multicollinearity (no pair exceeds r = 0.60). There is a moderate positive correlation between *Emissions* and *Resources Use* (r = 0.55), consistent with both capturing the same dimension of environmental performance; a moderate correlation between *Energy Intensity* and *Pollution Intensity* (r = 0.41), as expected given the common nature of intensities; and a negative correlation between *Leverage* and *ROA* (r = −0.34), consistent with the accounting relationship between Leverage and profitability.

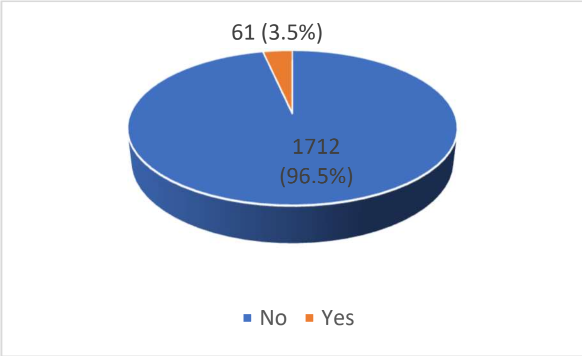

Figure 7. Environmental Controversies distribution.

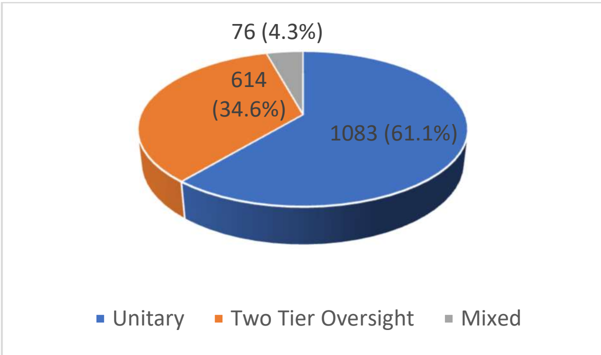

Figure 8. Board Structure Type distribution.

Table 4. Number of observations per Country and Sector.

	Sector									
Country	**Healthcare**	**Technology**	**Consumer Non-Cyclicals**	**Industrials**	**Utilities**	**Consumer Cyclicals**	**Basic Materials**	**Energy**	**Real Estate**	**Total**
Ireland	5	4	6	18	0	26	12	0	2	73
The Netherlands	5	26	17	24	0	14	21	0	11	118
Luxembourg	0	2	2	0	0	2	4	4	2	16
France	23	31	36	80	0	108	24	13	24	339
Germany	24	27	24	63	12	51	46	7	9	263
Spain	7	15	10	32	16	17	18	8	6	129
Italy	9	9	12	50	45	50	5	18	5	203
Belgium	6	14	21	0	2	3	11	0	7	64
Austria	0	9	0	18	0	6	22	4	2	61
Denmark	13	0	12	12	3	6	6	6	0	58
Sweden	12	24	15	71	0	52	21	0	14	209
Finland	4	14	10	32	0	24	26	4	1	115
Portugal	0	6	10	4	4	0	14	6	0	44
Hungary	0	6	0	0	0	0	0	6	0	12
Greece	0	5	4	7	10	1	0	1	0	28
Poland	0	6	0	0	10	4	9	4	0	33
Romania	0	0	0	0	0	0	0	3	0	3
Czech Republic	0	0	0	0	5	0	0	0	0	5
Total	108	198	179	411	107	364	239	84	83	1773

Table 5. Correlation matrix.

Variables	Emissions	Resources Use	Innovation	Energy Intensity	Pollution Intensity	Waste Intensity	Leverage	Full Time Employees	ROA	Independents Board Members	Environmental	Environmental Assurance	Certification	Controversies
Emissions	1													
Resources Use	0.549	1												
Innovation	0.2399	0.2352	1											
Energy Intensity	−0.0434	−0.1435	0.0415	1										
Pollution Intensity	−0.0256	0.0037	0.0962	0.4104	1									
Waste Intensity	0.0799	0.0436	0.0581	−0.1105	−0.0398	1								
Leverage	0.0422	0	0.0158	0.068	0.0719	−0.0298	1							
Full Time Employees	0.1657	0.2211	0.1692	0.1112	0.1019	0.0204	0	1						
ROA	0.0151	0.0802	0.0037	−0.0922	−0.1038	0.0254	−0.34	0.0047	1					
Independents Board Members	0.0315	0.0993	0.094	−0.0205	0.0927	−0.0844	−0.075	0.0367	0.0524	1				
Environmental	0.7383	0.7221	0.6862	−0.0224	0.0215	0.0471	0.0337	0.2119	0.0238	0.0944	1			
Environmental Assurance	0.1302	0.1895	0.1554	0.0524	0.0757	0.0398	0	−0.0684	0.1103	0.0457	0.2001	1		
Certification	0.1344	0.1119	0.1795	0.1798	0.2022	−0.0474	0.0658	0.1634	0.0012	0.1141	0.1671	0.1557	1	
Controversies	0.0963	0.1152	0.1517	0.0896	0.1116	−0.0512	0.0640	0.1842	−0.0218	0.0361	0.1722	0.1567	0.2210	1

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3.4. Model Specification

We test our hypotheses with firm Fixed-effects and Firth's logistic regression. We include *Environmental Assurance* $_{(n-1)}$ and *Certification* $_{(n-1)}$ indicators with one-year lag to mitigate concerns about reverse causality. We add standard controls widely used in the literature (*Leverage*, *Full Time Employees*, *ROA*, *Independent Board Members*, *Board Structure Type*, *Country*, and *Sector*).

To ensure the robustness of the results given the sample imbalance and potential issues with separation or rare events, we employed bootstrap technique with Firth's penalized logistic regression [79]. This method introduces a penalty term into the likelihood function, based on Jeffreys' invariant prior, which effectively reduces the small-sample bias inherent in standard maximum likelihood estimation [80]. Furthermore, to mitigate the influence of extreme observations, all continuous control variables were winsorized at the 2nd and 98th percentiles.

Equation (1): Fixed effects. Models 1–6:

$$Environmental\ Scores_{i,n} = \alpha + \beta_2 Audit_{i,n-1} + \beta_3 Certification_{i,n-1} + \beta_4 Control_{i,n} + Firm_i + \varepsilon_i \quad (1)$$

Equation (2): Firth's logistic regression:

We used logistic regression to predict several probabilities. The model used is as follows:

$$P(Y=1) = 1/\left(1 + e^{-Z_{i,n}}\right) \quad (2)$$

$Z_{i,n}$ represents the linear predictor or log-odds (logit) of the model, which is a linear combination of independent and control variables.

Equation (3). Models 7 and 8:

$$\begin{gathered} Y = EnvironmentalAssurance/Certification\ Y/N \\ Z_{i,n} = \beta_1 + \beta_2 Controversies_{i,n-1} + \beta_3 Environmental\ Score_{i,n} + \beta_4 Controls_{i,n} \end{gathered} \quad (3)$$

Equation (4). Models 9 and 10:

$$\begin{gathered} Y = Controversies/Certification\ Y/N \\ Z_{i,n} = \beta_1 + \beta_2 Environmental Assurance_{i,n-1}/CertificationYN_{i,n-1} + \beta_3 Environmental\ Score_{i,n} + \beta_4 Controls_{i,n} \end{gathered} \quad (4)$$

In models 11–16, the sample is segmented into distinct subgroups to examine potential heterogeneity across different contexts in Equation (4). Specifically, the analysis is partitioned by: (i) pollution sectors, distinguishing between high-polluting and low-polluting sectors; (ii) firm size, comparing large and small enterprises; and (iii) geographic region, isolating France and Germany from the remaining European Union countries.

This section details the study's empirical approach, using Refinitiv Eikon panel data from 441 EU-listed firms (2017–2023). It describes the measurement of environmental assurance, certifications, performance (sub-scores, intensity indicators), and media-reported controversies, along with the application of fixed-effects and Firth's logistic regression models.

4. Results

Table 6 presents the fixed effects models (Equation (1)). Overall, the results suggest that formal mechanisms that provide credibility (*Environmental Assurance* $_{(n-1)}$) or management structure (*Certification* $_{(n-1)}$) are associated with greater eco-efficiency and, when standards are combined, also with more innovation.

Table 6. Fixed-Effects models.

	(1)	(2)	(3)	(4)	(5)	(6)
	Emissions	**Resources Use**	**Innovation**	**Energy Intensity**	**Pollution Intensity**	**Waste Intensity**
Environmental Assurance $_{(n-1)}$	1.316 *	1.659 ***	1.249	−0.210 ***	−0.110 **	0.0396 ***
	−0.738	−0.614	−0.964	−0.0414	−0.0549	−0.00853
Certification $_{(n-1)}$:						
2. ISO $_{(n-1)}$	4.829 **	7.089 **	5.769	0.0439	−0.0938	−0.027
	−2.236	−3.015	−3.908	−0.257	−0.093	−0.0225
3. EMS $_{(n-1)}$	2.543	11.66 ***	−1.325	−0.832	−0.823	−0.160 **
	−2.352	−3.342	−6.495	−0.735	−0.505	−0.07
4. Both $_{(n-1)}$	6.390 **	6.293	11.86 **	0.0323	−0.508 ***	0.00606
	−2.885	−3.985	−4.715	−0.265	−0.175	−0.03
Control Variables						
Leverage	−0.289 **	0.116	−0.135	0.0123	−0.00804	0.00355
	−0.129	−0.169	−0.172	−0.0223	−0.00948	−0.00288
Full Time Employees	−0.0868	−0.24	0.0286	0.0131	−0.0275 **	−0.00468 *
	−0.215	−0.212	−0.304	−0.0114	−0.0128	−0.00278
ROA	−5.022	1.053	−2.186	−2.140 ***	−1.157 ***	0.0208
	−8.248	−6.707	−7.69	−0.413	−0.423	−0.135
Independent Board Members	2.216	1.43	9.577	0.17	−0.11	0.0455
	−4.29	−3.98	−6.184	−0.22	−0.221	−0.0505
Board Structure Type:						
2. Two Tier Oversight.	0.2	0.605	1.33	−0.00586	0.0356	−0.0221
	−1.801	−1.616	−1.676	−0.0671	−0.0803	−0.0239
3. Mixed	−1.194	−3.179 **	−2.565	0.159 *	−0.226	−0.0408
	−1.887	−1.437	−2.208	−0.088	−0.157	−0.027
Constant	74.20 ***	73.70 ***	45.38 ***	6.077 ***	6.936 ***	0.740 ***
	−3.839	−3.962	−5.974	−0.262	−0.199	−0.0432
Observations	1773	1773	1773	1773	1773	1773
Rho	0.83	0.85	0.84	0.93	0.86	0.84
F-statistic	3.7	3.38	3.9	10.29	2.85	4.45
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Hausman test	0.00	0.00	0.00	0.00	0.00	0.00

Notes: * *p*-value < 10%, ** *p*-value < 5%, *** *p*-value < 1%; standard errors are in parentheses. Hausman Test for all models is Prob > X^2 = 0.0000. Models 4 and 5 are log-level; therefore, their correct coefficients must be calculated with the formula: exp(coefficient) − 1. Certification categories are defined as: (1) None/No certification (reference group); (2) ISO 14001; (3) Environmental Management System (EMS); and (4) Both certifications. Board Structure Type is categorized as: (1) Unitary (reference group); (2) Two-Tier/Oversight; and (3) Mixed.

Environmental Assurance $_{(n-1)}$ is consistently associated with superior operational performance compared to peers without external verification: an improvement in *Emissions* (Model 1) of 1.31 score points, greater *Resources Use* efficiency (Model 2) by 1.65 score points, lower *Energy Intensity* (Model 4) of −19%, a reduction in *Pollution intensity* (Model 5) of −10%, and an increase in the *Waste Intensity* rate (Model 6) of 3.96%. In practical terms, firms that externally verify their environmental information tend to operate with lower energy and pollution intensity per unit of activity, while also achieving higher rates of waste recycling.

On the other hand, companies that undergo certifications processes show different patterns. *ISO* $_{(n-1)}$ is associated with better scores in *Emissions* (4.8 score points, Model 1) and *Resources Use* (7.08 score points, Model 2), while the combination of ISO $_{n-1}$ + another EMS $_{(n-1)}$ in *Innovation* (11.86 score points, Model 3) shows a possible complementary effect between standards. The *EMS* $_{(n-1)}$ displays a sharp increase in *Resources Use* (11.66 score points, Model 2) but a reduction in *Waste Intensity* (−16%, Model 6), a sign that not all schemes translate equally into circularity outcomes.

Among the controls, profitability (*ROA*) stands out, associated with much lower *Energy Intensity* −88% (Model 4) and *Pollution Intensity* −69% (Model 5) consistent with profitable firms operating more efficiently. In summary, the findings support the notion that *Environmental Assurance* $_{(n-1)}$ and, to a lesser extent, certain *Certifications* $_{(n-1)}$ (especially ISO and its combination with other EMS) are associated with tangible environmental improvements, while profitability (*ROA*) emerges as a powerful predictor of eco-efficiency. It does not appear that the different environmental structures of the board of directors have any significant overall effects.

Table 7 displays the results of the Firth's logistic regressions. Models 7 and 8 (Equation (3)) show how firms that have had some kind of adverse environmental news are almost three times more likely to review their environmental statements the following year ($e^{1.294} - 1$) (Odds = Probability of Event Occurring/Probability of Event Not Occurring = $p/(1-p)$, $p = 1/(1+e^{-z}) \rightarrow$ Odds = $\frac{p}{1-p} = e^{z} = e^{X\beta}$) and almost five times more likely to undergo certification ($e^{1.531} - 1$) compared to firms that have not reported any controversy.

Table 7. Firth's logistic regression models.

	(7)	(8)	(9)	(10)
	Environmental Assurance	**Certification**	**Controversies**	**Controversies**
Controversies $_{(n-1)}$	1.294 ***	1.531 *		
	(0.343)	(0.873)		
Environmental Assurance $_{(n-1)}$			1.099 ***	
			(0.359)	
Certification $_{(n-1)}$				1.048
				(0.919)
Environmental Score	0.0321 ***	−0.00271	0.0606 ***	0.0714 ***
	(0.00506)	(0.00673)	(0.0182)	(0.0184)
Control Variables				
Leverage	0.00413 ***	0.00370	0.00356	0.00367
	(0.00138)	(0.00385)	(0.00484)	(0.00421)
Full Time Employees	−0.127 ***	0.0885	0.441 ***	0.436 ***
	(0.0382)	(0.0561)	(0.133)	(0.130)
ROA	5.383 ***	2.425	−3.076	−1.952
	(1.445)	(2.236)	(3.768)	(3.577)
Independent Board Members	−0.0162	0.323	1.409	1.160
	(0.351)	(0.472)	(0.872)	(0.841)
Board Structure Type:				
2. Two Tier Oversight.	0.0735	−0.294	−0.510	−0.616
	(0.220)	(0.300)	(0.668)	(0.651)
3. Mixed	−0.536	−1.181 ***	0.519	0.310
	(0.376)	(0.426)	(0.991)	(0.985)
Constant	−2.929 ***	1.482	−14.96 ***	−16.34 ***
	(0.708)	(0.967)	(2.636)	(2.734)
Country	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes
Observations	1322	1322	1322	1322
Log-Likelihood	−663	−335	−114	−118
McFadden	0.117	0.223	0.410	0.388
Nagelkerke	0.184	0.283	0.446	0.424

Notes: * *p*-value < 10%, *** *p*-value < 1%; standard errors are in parentheses. Board Structure Type is categorized as: (1) Unitary (reference group); (2) Two-Tier/Oversight; and (3) Mixed.

Models 9 and 10 (Equation (4)) indicate that environmental assurance is positively associated with next-year media-reported environmental controversies, while certification is not statistically significant. This pattern is consistent with heightened scrutiny/visibility or selection/reverse causality, rather than evidence of intent. According to our results, these firms are twice as likely to have *Controversies* in the following year ($e^{1.099} - 1$). However, *Certification* $_{(n-1)}$ is not significant in the prediction of *Controversies*, but with a positive coefficient. The *Environmental* variable shows a clear significance in its relationship with Environmental Assurance and Controversies. Companies with good environmental performance could be encouraged to have this information endorsed by an external entity, which would expose them more to the media and increase the possibility of unwanted news. There does not seem to be a relationship between *Environmental* and undergoing *Certification* in the same period. All models exhibit acceptable levels of explanatory power, evidenced by the McFadden and Nagelkerke regression adjustment tests.

Finally, Table 8 presents several robust tests by segmenting the sample according to industry type, country size, and firm scale. We categorized sectors by pollution intensity, grouping high-polluting industries (such as Energy and Utilities) against less-polluting ones (such as Technology and Healthcare), and split the sample between major economies (France and Germany) and smaller countries. Additionally, we divided firms based on the median size of 11,270 employees. The results indicate that environmental assurance is only statistically significant for smaller firms operating in high-pollution sectors within smaller countries. All models demonstrate acceptable explanatory power according to McFadden and Nagelkerke tests; however, results for Certification are omitted as no primary variables reached significance in these sub-samples.

Table 8. Firth's logistic regression sample segmented models.

	(11)	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**
	Controversies (Sector More Pollutants)	**Controversies (Sectors Less Pollutants)**	**Controversies (France and Germany)**	**Controversies (Rest of the Countries)**	**Controversies (>Employees Median)**	**Controversies (<Employees Median)**
Environmental Assurance $_{(n-1)}$	1.168 ***	0.223	0.754	1.208 **	0.548	1.392 *
	(0.394)	(0.882)	(0.501)	(0.546)	(0.418)	(0.817)
Environmental Score	0.0712 ***	−0.0223	0.0856 ***	0.0323	0.0385 **	0.0979 **
	(0.0209)	(0.0454)	(0.0278)	(0.0277)	(0.0195)	(0.0499)
Control Variables						
Leverage	0.00230	0.0210	0.00324	0.00208	0.00493	−0.00426
	(0.00539)	(0.0141)	(0.00547)	(0.00703)	(0.00625)	(0.00598)
Full Time Employees	0.337 **	1.116 *	0.434 ***	0.244	1.188 ***	−0.125
	(0.135)	(0.646)	(0.159)	(0.227)	(0.297)	(0.322)
ROA	−1.181	−11.69	−9.380 *	4.492	−5.974	4.054
	(4.087)	(11.63)	(5.385)	(5.528)	(4.368)	(9.369)
Independent Board Members	0.564	5.232 *	0.417	2.411	1.163	−1.657
	(0.936)	(2.853)	(1.068)	(1.801)	(1.010)	(2.241)
Board Structure Type:						
2. Two Tier Oversight.	−0.649	1.127	−0.654	−1.388	−0.593	−0.499
	(0.822)	(1.650)	(0.976)	(1.039)	(0.840)	(1.993)
3. Mixed	0.637	1.409	0.982	0.624	0.623	0.633
	(1.008)	(2.242)	(2.715)	(0.973)	(1.083)	(1.787)
Constant	−15.50 ***	−16.44 *	−13.33 ***	−12.71 ***	−20.53 ***	−10.11 **
	(2.756)	(8.561)	(2.843)	(3.869)	(3.851)	(4.896)
Country	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes
Observations	905	417	456	866	684	638
Log-Likelihood	−91	−20	−53	−49	−85	−24
McFadden	0.193	0.228	0.473	0.394	0.401	0.552
Nagelkerke	0.454	0.239	0.528	0.416	0.452	0.573

Notes: * p-value < 10%, ** p-value < 5%, *** p-value < 1%; standard errors are in parentheses. Board Structure Type is categorized as: (1) Unitary (reference group); (2) Two-Tier/Oversight; and (3) Mixed.

Hypothesis 1 is supported (Table 6), as *Environmental Assurance* $_{(n-1)}$ shows the expected significant associations (positive for the different environmental scores and the recycling rate, and negative for the intensities). Especially for the most crucial variables such as intensities, companies that externally verify their environmental status achieve very significant improvements

Hypothesis 2 (Table 6) receives partial support: *ISO* $_{(n-1)}$ and, especially, its combination with another *EMS* $_{(n-1)}$, are linked to better significant environmental scores, but the results in intensities are not significant in general, in particular, we observe that the *ISO* $_{(n-1)}$ coefficient for *Energy Intensity* (Model 4) was not significant; meanwhile, the *EMS* $_{(n-1)}$ improves *Resources use* (Model 2) but reduces *Waste Intensity* (Model 6), pointing to circularity trade-offs. *Certifications* $_{(n-1)}$ are clearly linked to performance scores, especially when *ISO* $_{(n-1)}$ is combined with another *EMS* $_{(n-1)}$, suggesting complementarity between standards.

Hypothesis 3.1 is supported (Table 7). It seems clear that the entities in the spotlight seek some kind of legitimacy, either voluntarily or forced by their environment, by reviewing their environmental performance or undergoing some kind of certification.

Finally, Hypothesis 3.2.2 is supported for the assurance variable (Table 7), as we find evidence that it is associated with a higher likelihood of next-year media-reported environmental controversies. This pattern is consistent with heightened visibility and external scrutiny of assured firms (e.g., firms may adopt assurance in response to elevated controversy risk), rather than with a clear reduction in controversy exposure.

The results show that environmental assurance is consistently linked to higher environmental sub-scores and lower energy/pollution intensity, while certification effects are weaker.

5. Discussion

Our findings in Table 6, Models 1 to 6, suggest a functional divide between environmental tools: while audit (*Environmental Assurance*), *ISO* and *EMS* certifications (Models 1–3) are effective at signalling management quality and boosting ESG reporting scores (Emissions, Resources Use, and Innovation reported by EIKON), only *Environmental Assurance* seem to serve as a substantive governance mechanism that translates into real-world efficiency (Models 4–6). This outcome strongly supports Hypothesis 1, aligning with the "signaling theory" as highlighted by Abay [44] and Arena et al. [45], who emphasize assurance's role in differentiating high-performing firms and enhancing the reliability of sustainability information. The findings are also consistent with Dutta [8] and Gan et al. [43], suggesting that environmental auditing enhances the reliability of ESG disclosures and reduces information asymmetry. Beyond the signaling effect, these results indicate that assurance may also foster greater measurement discipline and the identification of operational inefficiencies, which in turn reflect improved environmental scores and lower resource intensities.

In contrast, the effects of environmental management certifications (such as ISO 14001/14064 [4,5] and EMAS [6]) on performance indicators are found to be weaker and more heterogeneous. While Hypothesis 2 anticipated superior performance, our evidence reveals a more complex scenario. We find only a significant, but more intense effect, on pollution intensity when EMAS and ISO are implemented over Assurance. This aligns with criticisms by Daddi et al. [10] and Marrucci and Daddi [64], who found that EMS implementation might not always lead to uniform environmental improvements, and in some cases, even a slight deterioration in performance indicators. The transition dynamics that occur when a certification is adopted (integrations costs, equipment, and testing) can worsen intensity indicators in the short term [11].

This heterogeneity implies that while certifications aim to promote responsible environmental management [4,6], their practical impact might be moderated by the effectiveness of implementation, sectoral, and contextual factors, sometimes operating as a "ritual of legitimacy" rather than driving substantive change [73].

Concerning environmental controversies, our study yields critical insights into the dynamics of reputational exposure. We find support for Hypothesis 3.1 (Table 8, Models 7 and 8), indicating that firms experiencing controversies in one period are more likely to seek environmental assurance or certification in the subsequent period. This result suggests that entities under public scrutiny seek to repair their social standing by engaging in practices that enhance their environmental credibility. This behavior aligns with legitimacy theory, which suggests that organizations utilize symbolic and substantive actions to regain social acceptance after a legitimacy threat [13]. Our findings thus extend the well-established link between controversies and disclosure [81] to the specific context of third-party environmental verification.

Furthermore, our analysis supports Hypothesis 3.2.2 for the environmental assurance variable, demonstrating that assured firms face a higher likelihood of next-period media-reported environmental controversies. However, albeit real improvements in environment intensities our results also suggest in Model 9 that *Environmental Assurance* subjects the firm to a critical spotlight that formal certifications do not (Model 10). This counter-intuitive finding, which contradicts Hypothesis 3.2.1, is interpreted not as evidence of "greenwashing" by assured firms, but rather as a consequence of heightened visibility and external scrutiny. As suggested by Gan et al. [43], environmental assurance can strengthen public supervision and prompt greater media attention to environmental performance. Although certifications implementation does not always improve environmental intensity, the results show that firms may, in part, successfully close 'legitimacy gaps' without triggering the heightened external scrutiny that typically follows high-profile environmental reporting, perhaps because they address the root causes of environmental impact through standardized management systems.

Focusing on Environmental Assurance, our sub-sample analysis (Models 11–16) provides evidence that reinforces the "visibility hypothesis" across different corporate contexts. The positive association between environmental transparency and controversies is notably concentrated in highly sensitive environments. Specifically, the impact of the Environmental Assurance and Environmental Score is strongest and highly significant in high-pollutant sectors. Thus, in sectors where the environmental impact is already under the microscope, transparency acts as a catalyst for stakeholder scrutiny [12].

Our analysis also reveals that the mechanism of stakeholder scrutiny is highly context-dependent, shifting between institutional environments. In high-regulation countries like France and Germany, the Environmental Score acts as the primary catalyst for controversies. In these jurisdictions, where ESG standards are already stringent, stakeholders bypass Assurance informs to scrutinize the firm's overall reported performance, treating high scores as benchmarks for accountability. Conversely, in the rest of the countries (Model 14), the relevant signal shifts to Environmental Assurance. In these markets, where institutional oversight may be less systematic, a third-party audit (Assurance) serves as a more visible and discrete event that attracts external attention [14]. This suggests that while the "visibility effect" is universal, the specific vehicle of that visibility, be it the aggregate score or the external audit, is determined by the maturity of the local regulatory environment.

Finally, the results regarding company size (Models 15 and 16) indicate that while larger firms face systematic scrutiny regardless of independent assurance report, for smaller firms, the adoption of Environmental Assurance serves as a more visible signal that attracts external monitoring [64]. Collectively, these results confirm that the feedback loop is not a statistical artifact, but a strategic reality conditioned by sector-specific and institutional greenwashing regional pressures.

While our analysis acknowledges the inherent feedback loop between environmental transparency and corporate controversies from models 7 to 16, by lagging the independent variables $(_{n-1})$, we mitigate simultaneity bias. Furthermore, by controlling for firm size, financial performance, and governance structure, we mitigate the influence of confounding factors, allowing us to identify a systematic mechanism.

This result addresses a key research gap by providing panel evidence linking credibility-enhancing mechanisms to next-year controversies, framing controversies as a proxy for reputational exposure and external monitoring rather than managerial intent of greenwashing.

6. Conclusions

The study's primary findings reveal that environmental assurance consistently implies enhanced environmental performance, as evidenced by higher Refinitiv environmental sub-scores (Emissions, Resource Use, Innovation) and reduced energy and pollution intensity. In contrast, environmental management certifications, such as ISO 14001, exhibit weaker and more heterogeneous effects on intensity-based indicators, though they also are linked to improved environmental scores, particularly when combined with other EMS schemes.

Drawing on Legitimacy Theory, our findings suggest that environmental assurance is not merely a technical tool for accuracy, but a strategic response to 'legitimacy gaps' created by environmental controversies. The strong predictive power of *Controversies* $_{(n-1)}$ on the adoption of *Environmental Assurance* and *Certifications* supports the view that firms utilize third-party verification as a repair mechanism when their social contract is threatened. This creates a reciprocal relationship: while controversies drive the demand for assurance, the adoption of such practices is most prevalent among firms whose operations inherently attract greater stakeholder monitoring and higher controversy risks.

Critically, assured firms demonstrate a higher likelihood of subsequent media-reported environmental controversies, interpreted not as evidence of greenwashing but rather as a consequence of heightened external scrutiny and visibility. From a Signalling Theory perspective, the positive association between the *Environmental Score*, *Environmental Assurance* and *Controversies* indicates that high levels of environmental disclosure may act as a 'red flag' for professional non-governmental organizations (as Greenpeace) and regulators, who scrutinize high-scoring firms more rigorously. This increased scrutiny is concentrated in high-pollutant sectors, more regulated countries, and for smaller firms. This confirms the existence of a feedback loop, or endogenous relationship, where firm visibility, environmental performance reporting, and external scrutiny co-evolve. Thus, these coefficients reflect a complex equilibrium of corporate signalling and external accountability.

Our findings offer critical insights for practitioners, investors, and policymakers. For corporate managers, the divergence between assurance and certification suggests that transparency without operational depth creates reputational vulnerability. Firms should prioritize process-based certifications to build an 'operational shield' before aggressively signaling high environmental scores.

For investors, the results indicate that high ESG scores in stringent institutional environments may act as a catalyst for scrutiny rather than a guarantee of safety; therefore, due diligence should focus on the substance behind the signal.

Finally, for policymakers, there is a clear need to evolve current environmental auditing standards. To mitigate the 'visibility effect' that triggers controversies, limited assurance should be enhanced toward more reasonable and technical standards, like environmental certifications. By integrating operational verification into disclosure audits, regulatory

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frameworks can ensure that environmental transparency reflects genuine corporate performance rather than symbolic signalling, ultimately leading to a more stable and accountable ESG ecosystem.

Because our study period (2017–2023) includes the COVID-19 pandemic, the results regarding environmental intensity and media reporting must be interpreted with caution. Since the main intensity indicators are tied to revenue, pandemic-related drops in sales can make environmental performance look worse even if actual emissions did not increase.

More comprehensive data panels, both in terms of time and number of geographical areas, could provide a clearer picture of the results. On a technical level, more sophisticated analytical tools, together with advances in AI, could help strengthen consistency checks and anomaly detection in sustainability reporting and assurance.

Future research could further address endogeneity by employing advanced econometric techniques, such as Instrumental Variables (IV) or Dynamic GMM estimators, to isolate the exogenous component of environmental disclosure. However, it is important to recognize that the observed endogeneity may not merely be a statistical challenge, but a reflection of the natural cycle of corporate accountability. In the ESG landscape, transparency and scrutiny co-evolve in a dynamic feedback loop. Thus, rather than aiming to eliminate this relationship, future studies should focus on modelling this co-evolution to better understand how firms and stakeholders reach a strategic equilibrium in highly sensitive institutional environments.

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Abbreviations

The following abbreviations are used in this manuscript:

EMAS	Eco-Management and Audit Scheme
NFRD	Non-Financial Reporting Directive
CSRD	Comprehensive Corporate Sustainability Reporting Directive
RBV	Resource-Based View
EMS	Environmental Management System

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