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RESEARCH ARTICLE



Environmental photograph use in corporate sustainability reporting: A machine-supported visual content analysis

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Abstract

Despite the prevalence of photographs in corporate sustainability reporting, their use is not yet sufficiently understood. To the best of our knowledge, this paper is the first large-scale study in the field. Introducing a novel machine-supported approach, we assess environmental photograph utilization based on a sample of 45,228 photographs contained in 1,463 separately disclosed sustainability reports from European firms between 2011 and 2020. We find that against the overall trend of decreasing photograph utilization, the share of environmentally themed photographs has markedly increased. Furthermore, operating in an environmentally sensitive industry is strongly associated with a substantially larger share of photographs depicting environmental subject matter. Lastly, we observe that companies signal their superior environmental performance through greater utilization of environmental photographs. By introducing a novel machine-supported approach to analyzing photographs, this study makes a methodological contribution to the field of sustainability reporting. Our results also have important practical implications.

KEYWORDS

corporate sustainability reporting, environmental, photograph use, photograph use, computer vision

1 | INTRODUCTION

To counter legitimacy threats arising from environmental pollution or poor working conditions, companies may resort to shaping the perception of their impact on stakeholders and society at large (Cho & Patten, 2012). Deliberate attempts to influence the perception of an organization's legitimacy, e.g., by manipulating content and appearance of information, are helped by the information advantage managers enjoy over the report's readers (Merkl-Davies & Brennan, 2007, 2011).

Photographs, in particular, are well suited to communicate sustainability-related topics, as complex and less quantifiable messages in the indistinct future are often more effectively conveyed through photographs than numbers or words (Anderson, 1980; García-Sánchez & Araújo-Bernado, 2020; Rämö, 2011). Moreover, visuals enjoy a more prominent place in cognitive memory than

Abbreviations: ENV PUT, environmental photograph utilization; ENV share, environmental photograph share; ESG, Environmental, Social and Governance; EU, European Union; PDF, portable document files; PNG, portable network graphics; PUT, photograph utilization; VIF, variance inflation factor.

In the realm of corporate sustainability reporting, the role of photographs remains underexplored. This paper introduces a machine-supported approach based on computer vision to examine the use of photographs, and in particular environmental photographs. Analyzing 45,228 photographs contained in 1,463 sustainability reports from European companies, our findings challenge the prevailing notion of sustainability reports becoming ever more densely filled with photographs. In addition, we observe a notable increase in environmental photograph use. Particularly, companies operating in environmentally sensitive industries exhibit a significantly higher proportion of such visuals. This study not only facilitates a novel approach to studying photograph use but also holds practical significance, shedding light on the evolving field of corporate sustainability reporting.

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written text (Tversky, 1974) and can engender framing effects or thought patterns (Tversky & Kahneman, 1986). Scientific studies have cautioned that photographs are used beyond decorating textual information; however, research has not kept pace with elaborate practices of visual communication employed by the private sector (Breitbarth et al., 2010; Davison, 2015; Davison & Warren, 2009). Previous articles find that photographs are used to symbolically pursue legitimacy by creating idealized visions, which do not typically reflect companies' business conduct (Boiral, 2013; Breitbarth et al., 2010; Hrasky, 2012). More recent studies confirm that managers use their discretion to project the image of a responsible and trustworthy corporate citizen, while negative aspects are all but absent in the visual realm (García-Sánchez & Araújo-Bernado, 2020; Nicolò et al., 2022). However, most existing studies rely on small samples, which often come from a single industry, single country, single reporting period, or case study (Invernizzi et al., 2021; Rämö, 2011).

Understanding photograph use is also of great practical relevance, as even seasoned investors are swaved by aesthetics in corporate reporting (Townsend & Shu, 2010). Comparing different types of disclosure, photographs are most extensively employed in corporate sustainability reporting, where they constitute an integral element (Boiral, 2013; Breitbarth et al., 2010; Davison, 2015; Invernizzi et al., 2021; Rämö, 2011). The medium of sustainability reports has also gained importance as the salience of corporate sustainability has markedly increased (Arvidsson & Dumay, 2022). Furthermore, the substantial cost of printing and distributing hard copy, photograph-rich sustainability reports have all but evaporated as corporate communication is most usually shared digitally, which may have influenced how managers design sustainability reports. This predilection for using photographs may also be adopted by small- and medium-sized enterprises (de Villiers & Alexander, 2014; Shabana et al., 2017), which are soon to be subjected to expanded reporting requirements in the European Union (European Parliament & European Council, 2022). Given the concerning use of photographs reported in related studies, we argue that it is important to understand their power to sway readers' opinions. Despite their important role and well-documented potency, the use of photographs remains a blind spot in corporate sustainability reporting.

Given the inherent limitations to existing studies, we contribute generalizable findings on the use of photographs in European corporate sustainability reporting, which feature both longitudinal coverage and cross-sectional variation. We quantify the overall use of photographs and assess the themes depicted therein. Our machinesupported analysis of photographic content focuses in particular on photographs conveying environmental subject matter to account for the outsized role of the environmental pillar within corporate sustainability. While the significance of environmental concerns within corporate sustainability has been a constant, its relative importance has gained new momentum as evident by the ambitious regulatory agenda pursued by the European Union (EU), an increased general public awareness, e.g., global climate demonstrations, and intensified involvement of the financial community, e.g., 'Climate Action 100+ group'. In addition, we argue that environmental themes can also be more reliably identified than more abstract concepts, such as labor

relations or corporate governance. Our research is thus guided by the following research question:

To what extent do companies use environmental photographs in their corporate sustainability report?

Moreover, we have identified three supportive research questions that are intended to guide our research and shed light on specific aspects of our study's focus:

- How has photograph use changed over time?
- How is the relationship between photograph use and sustainability performance?
- How does photograph use vary across different industries?

We employ Google's Vision API, a commercial pre-trained computer vision service (Google LLC, 2023), to derive sophisticated insights into large image data sets. Advances in artificial intelligencepowered software and computing resources enable researchers to analyze and draw conclusions based on large-scale data sets. While machine-supported software has been put to use in many fields of academia, its application in the context of corporate sustainability reporting is to date largely confined to textual analysis, and recent examples include Niehoff (2022) and Bhandari et al. (2022). In particular, we use the label detection feature to retrieve photographic content by ascribing labels. To classify whether photographs depict environmental subject matter, we developed a codebook based on the detected labels ascribed by the vision models. Our machine-based approach allows for the analysis of much larger image data sets than previously feasible. To the best of our knowledge, this is the first large-scale study on the use of photographs in corporate sustainability reports, which applies a machine-supported visual content analysis. We assess overall photograph utilization and focus our analysis on the use of photographs conveying environmental subject matter.

Based on a sample of 45,228 photographs contained in 1,463 separately disclosed reports from 2011 to 2020, we cannot confirm the general belief that sustainability reports are becoming ever more densely filled with photographs. Against this observed trend of falling photograph utilization over the last decade, the percentage of environmentally themed photographs has markedly increased. From our regression models, we find that, firstly, operating in an environmentally sensitive industry (Branco & Rodrigues, 2008; Clarkson et al., 2011) is associated with a substantially higher percentage of photographs depicting environmental subject matter. Secondly, we find that companies with higher environmental credentials signal their superior performance through a higher share of environmentally themed photographs. Both findings are highly significant and very robust with regard to changes in the methodology for identifying environmental photographs. In this study, we introduce a novel approach to assessing photograph use in corporate reporting. Furthermore, we contribute to the existing literature by providing empirical evidence of overall photograph use and, in particular, the utilization of environmental photographs by European companies.

The remainder of this article is organized as follows: Section 2 consists of the literature review and the derivation of our research

question. In Section 3, we outline our research approach, which is followed by the empirical results in Section 4. Section 5 discusses the findings as well as limitations and suggestions for future research. Lastly, Section 6 provides the conclusion of this paper.

2 | BACKGROUND

2.1 | Characteristics of sustainability reporting

Over the last two decades, sustainability-related topics have increasingly occupied annual reports (Davison & Warren, 2009). Simultaneously, many companies have begun to voluntarily disclose a sustainability report along with their financial reporting. Since 2017, large legal entities domiciled in the European Economic Area have been legally obliged to annually disclose non-financial information to the public. The 2014/95/EU directive (European Parliament & European Council. 2014) mandates the comprehensive discussion of a wide range of topics, ranging from environmental considerations and labor relations to anti-slavery practices. While the law dictates that the report includes certain topics, companies do not need to abide by a strict reporting framework (Fiechter et al., 2022). Most of the sustainability information reported by companies can still be considered voluntarily disclosed information (Christensen et al., 2021). In the absence of a harmonized reporting standard, managers enjoy large discretion over the design of their sustainability reporting.

The companies' motivations for disclosing voluntary sustainability reports vary greatly (Herzig & Schaltegger, 2011). These include showcasing the company in a positive light, gaining a comparative edge over competitors (Frias-Aceituno et al., 2014), and/or mitigating stakeholder pressures and interference by government agencies (Gray et al., 1995; Prado-Lorenzo & García-Sánchez, 2010; Reverte, 2009). Legitimacy theory is most commonly used to explain sustainability disclosure by companies. Following Deegan (2002), companies require legitimacy not only from core stakeholders but also seek to repair or maintain legitimacy in the eyes of society, on which they continuously depend for resources and approval (Beattie & Jones, 2008; Hahn & Lülfs, 2014; Milne & Patten, 2002). Legitimacy can be understood as a temporary social contract, which is granted by society to responsibly operating companies (Ashforth & Gibbs, 1990; Hrasky, 2012). Following Suchman (1995), organizational legitimacy can be attained either as moral legitimacy, backed up by the firm's business conduct, or through symbolic attempts to project the image of a caring corporate citizen. As their legitimacy rests on staying within a set of social boundaries (Deegan, 2002), companies may use sustainability disclosure to legitimatize their operations to their stakeholders (Cho & Patten, 2012; Guthrie & Parker, 1989).

On the other hand, voluntary disclosure theory and, by extension, signaling theory are also extensively used to explain voluntary reporting of non-financial information to the public (Clarkson et al., 2008; Mahoney et al., 2013). Therefore, companies with superior sustainability performance choose to voluntarily disclose otherwise unobservable sustainability information to increase their financial value (de Villiers &

Marques, 2016; Dhaliwal et al., 2011; Hummel & Schlick, 2016). In this context, signaling refers to the attempt to communicate a firm's superior sustainability achievements (Connelly et al., 2011; Rezaee, 2016). Even so, disclosure is costly; firms with superior sustainability credentials benefit from the comparison differentiating them from their peers through voluntary sustainability disclosure (Mahoney et al., 2013). To present these achievements through corporate sustainability reports, managers have a versatile communication toolbox at their disposal.

2.2 | Visual communication

Photographs have become ubiquitous in our visualized and digitized world of business. In the context of corporate reporting, the growth of visual material over the last decades has been recognized by several studies (Beattie & Jones, 2008; Davison & Skerratt, 2006; Lee, 1994; Usmani et al., 2020). Comparing different venues of corporate reporting, studies have shown that photographs are especially prevalent in corporate sustainability reporting and constitute an integral feature of such reports (Boiral, 2013; Invernizzi et al., 2021; Rämö, 2011). Many researchers have expressed concern that the use of richer media gives companies a very potent tool, which can be leveraged for rhetorical or persuasive purposes (Cho et al., 2009). Photographs may construct what corporate sustainability means to whom (Breitbarth et al., 2010), divert attention from adverse information (Arora & Lodhia, 2017), or alter the perception of non-financial performance (Cho et al., 2010; Hrasky, 2012; Mahoney et al., 2013; Peeples, 2011). Hopwood (2009) argues that sustainability disclosure filled with visual imagery may obfuscate the true content and thus potentially decrease corporate transparency. High-quality photographs, professionally shot and at times covering an entire report page, are intentionally and deliberately used (Breitbarth et al., 2010; Davison, 2015; García-Sánchez & Araújo-Bernado, 2020). Graphic elements such as photographs naturally stand out from the surrounding text and attract the reader's attention through a so-called 'pop-up effect' (Treisman, 1985). Richer media seems to be especially well suited when there is ambiguity about the interpretation of the underlying issue (Cho et al., 2009; Daft & Lengel, 1986).

Photographs serve several purposes in long text documents. They orientate readers, thus enhancing information processing fluency (Invernizzi et al., 2021). In addition, readers are more likely to select texts with photographs, which enhances the overall attractiveness of reading a text document (Knobloch et al., 2003). On the other hand, visuals may be used to guide readers to more favorable sections of the report (Usmani et al., 2020). The capacity of photographs to communicate complex messages to a diverse audience makes them a very powerful tool for disseminating information (Anderson, 1980; Coleman, 2010). This is especially true compared to textual information, where complex messages may be lost to complicated language (Rämö, 2011). Studies suggest that visuals are not only easier to recall in many situations (Paivio, 1969) but are also better retained over the long-term (Paivio et al., 1968). Individuals also tend to spend more time looking at visual material than texts (Tversky, 1974) and become

biased toward the image if the two media give opposite cues (Zillmann et al., 1999).

Furthermore, the capacity of photographs to 'create reality' (Preston et al., 1996) makes them especially persuasive, as they are perceived to capture the real world (Pesci et al., 2015). Photographs can be leveraged to misrepresent reality (Caron & Turcotte, 2009), especially in fairly contested domains such as corporate sustainability (Hallin et al., 2021; Meuer et al., 2020). Following Bansal and Kistruck (2006), photographs can therefore be used to create a convincing account of the subject matter irrespective of actual implementation. Photographs also have the capacity to engender thought patterns and engender framing effects to guide the readers' thinking (Tversky & Kahneman, 1986). The strategic and deliberate attempt of firms to positively influence public opinion about their image is called impression management (Hooghiemstra, 2000; Merkl-Davies & Brennan, 2007).

Following Davison (2015), corporate sustainability reporting has inherent characteristics that make it ideal for leveraging visual communication. Compared to financial disclosure, it speaks to a much wider audience, including non-professional and less experienced stakeholders (Rämö, 2011). Furthermore, it tends to be forward-looking and more qualitative in nature, stemming from the long time horizon of some of the topics covered. The dissemination of mostly qualitative information also results in less comparable measures of performance (Anderson, 1980; Cho & Patten, 2007; Rämö, 2011). In light of the substantial discretion reporting managers enjoy over their sustainability disclosure, photographs are a very potent tool used to showcase the company in the most favorable light. The importance of understanding companies' visual reporting behavior is furthermore underscored by the findings of Townsend and Shu (2010), who showed that even seasoned investors are swayed by the aesthetics of corporate reporting.

2.3 | Related work and research gap

We argue that it is very important to shed more light on the subject as research has lagged behind the sophisticated practices of the private sector (Davison, 2015). Despite a number of existing studies, the understanding of photograph use in corporate sustainability reporting remains insufficient. As these studies rely on the manual assessment of photographic content, the sample size of the underlying reporting data is inherently limited. While the majority of studies provide a lot of analytical depth, their findings can seldom be generalized beyond the observed phenomenon. Most are based on cross-sectional data from a single industry or country (Boiral, 2013; Cabrera-Narváez & Quinche-Martín, 2021; Invernizzi et al., 2021; Rämö, 2011; Zeng et al., 2022), multiple cases studies (Ali et al., 2021; Breitbarth et al., 2010; Corazza et al., 2020; Pérez-Cañizares, 2022), or jointly analyze graphs and photographs as visual disclosure (Hrasky, 2012; Nicolò et al., 2022). The remaining contributions, which feature both longitudinal coverage and cross-sectional variation, include only a few dozen reports from a single country (Chong et al., 2019; García-Sánchez & Araújo-Bernado, 2020).

Most studies underscore the centrality of photographs in corporate sustainability reports, which are an integral part of the reporting toolbox (Boiral, 2013; Breitbarth et al., 2010; Zeng et al., 2022). While the extent of photograph use seems to vary markedly between companies (Invernizzi et al., 2021), many authors observe that photographs have become more heavily used in recent years (Ali et al., 2021; Anantharaman et al., 2020; Beattie et al., 2008; Chong et al., 2019). However, we believe that these differences may not only be due to sample selections but also to different measures of photograph use, e.g., counting the number of photographs may produce very different results than assessing photographs against the number of report pages.

Despite employing different measures, both Anantharaman et al. (2020) and Nicolò et al. (2022) find that companies operating in environmentally sensitive industries make more use of visual disclosure. Moreover, some evidence exists that photograph use negatively correlates with both the number of topics disclosed in the report as well as CSR performance (Anantharaman et al., 2020). On a similar note, Hrasky (2012) and García-Sánchez and Araújo-Bernado (2020) both observe that companies that are less motivated by sustainability use a more symbolic approach to photograph use, e.g., through the use of non-specific photographs. Furthermore, the photographs generally convey idealized visions of sustainability disconnected from the operational reality, while negative cues are almost completely absent from the visual level (Boiral, 2013; Breitbarth et al., 2010; Chong et al., 2019). Regarding the subject matter depicted in the photographs, existing studies find very different patterns that may plausibly be explained using industry-specific samples. Rämö (2011) and Boiral (2013) find large percentages of environmentally themed photographs, while Invernizzi et al. (2021) and Hrasky (2012) observe socially themed as well as product- and operations-related photographs to be most extensively used. Longitudinal studies by Pérez-Cañizares (2022) and Chong et al. (2019) find an increased focus on depicting people in the photographs. However, as previously pointed out, all studies are characterized by a very limited sample size, often based on a single industry, country, and/or reporting period. Thus, their findings should be interpreted with caution. Despite the richness of their analysis, their results may not be generalizable beyond the particular phenomenon.

Hence, we still observe substantial knowledge gaps in the understanding of photograph use in corporate sustainability reports. Firstly, there is a lack of coherent measures to assess photographs in reporting documents and, as a consequence, a basic understanding of the extent of overall photograph use. Secondly, the relative importance of the specific subject matter depicted in photographs is only documented in industry-specific studies. Thirdly, there is scant evidence of how overall photograph use as well as the use of certain themes varies across company characteristics. Some studies observe that industry affiliation and sustainability performance are positively associated with photograph use. We are interested in whether this relationship also holds for subject matter-specific photographs.

To address these gaps, we conduct a longitudinal study to provide comprehensive empirical evidence of the role of photographs in corporate sustainability reporting. Accordingly, we seek to contribute more generalizable findings on visual reporting behavior by European companies. To this end, a new methodological approach is introduced to quantify overall photograph use and facilitate a machine-supported content analysis of large photographic data sets. We thus shed light on the subject matter conveyed through photographs. Given the wide range of visual themes communicated in the reports, we focus our analysis on photographs depicting environmental themes. While each stakeholder has a different set of priorities with regard to corporate sustainability, we argue that the environmental pillar of corporate sustainability is arguably the most pressing. In Europe, this is manifested by an ambitious regulatory agenda centered around the European Green Deal (European Commission, 2019). It covers a range of initiatives including steering financial capital towards green activities, i.e., EU Taxonomy (European Parliament & European Council, 2020), more stringent sustainability reporting requirements, i.e., Corporate Sustainability Reporting Directive (European Parliament & European Council, 2022), and a framework for achieving climate neutrality, i.e., European Climate Law (European Parliament & European Council, 2021). Furthermore, these priorities can also be observed in the heightened interest from the financial community, e.g., the 'Climate Action 100+ group', green bond issuance, as well as general public awareness through the prominence of the reports by the Intergovernmental Panel on Climate Change or societal and political movements.

On a more practical note, we also argue that objects indicating environmental subject matter can be more reliably identified compared to more abstract concepts, such as labor relations or corporate governance. To live up to the relative importance of the environmental pillar within corporate sustainability, we focus our analysis on the visual communication of environmental subject matter.

METHODOLOGY 3

In the following section, we introduce our novel machine-supported content analysis approach. Firstly, we outline the sample selection process and describe how we access photograph data from corporate sustainability reports. Thereafter, the identification of environmental subject matter within the photographs is presented. Lastly, we put forward a measure of photograph utilization and specify the regression models employed.

3.1 Sample selection and data extraction

For this study, we collected data from 10 consecutive reporting periods between 2011 and 2020. We consider all companies from countries in the European Economic Area, which have continuously been part of the STOXX Europe 600 index between January 2011 and December 2020. In this way, we can ensure that all firms are subject to a very similar regulatory environment and financially stable. To accurately assess photograph utilization in European corporate sustainability reporting, we limit our sample to stand-alone sustainability reports. This allows us to unequivocally attribute every photograph to

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a company's sustainability disclosure. For this study, we require that a separately published sustainability report is not additionally contained as a chapter within the annual report. Furthermore, the reporting period has to match the corresponding calendrical year. The corporate sustainability reports were downloaded as portable document files (PDFs) from corporate websites and the GRI Sustainability Disclosure Database (Global Reporting Initiative, 2020) in September 2020 and November 2021. Our final sample contains 1,463 stand-alone sustainability reports from 221 companies consisting of 128,875 pages of sustainability-related disclosure. We summarize the sample selection process in Table 1.

We extracted the photographs contained in the reports with a Python script built upon the 'fitz' functionality module (Kastman, 2017). The program retrieves the image files as portable network graphics (PNGs). In four instances in which the script was unable to extract the image files from the report, we used a webbased extraction tool (Spikerog SAS, 2020). As not all image files contained in the reports are actual photographs, we had to clean the data set from non-photographic PNG files (Rämö, 2011), e.g., charts,

TABLE 1 Sample selection process.

Step	Explanation	Number of companies
	We chose the STOXX Europe 600 index which covers the 600 largest publicly listed companies in Europe.	600
1	We included only companies in our sample which have continuously been part of the STOXX 600 Europe index between January 1st, 2011, and December 31st, 2019, the start and end date of the ten-year study period. Companies which ceased to exist or entered the index in more recent years were not considered.	(–256)
2	We excluded companies which are not incorporated in the European Economic Area, i.e. Swiss companies, as they are not subject to the European Union's sustainability reporting regulation.	(-31)
3	We considered only stand-alone sustainability reports as opposed to integrated report chapters included in annual reports. Thus, we can unequivocally attribute every photograph employed to the company's sustainability reporting. Moreover, we required that the reporting period has to match the corresponding calendrical year.	(-92)
	Our final sample contains 1,463 stand-alone sustainability reports from 221 companies consisting of 128,875 pages of sustainability- related disclosure. The 1,463 sustainability reports contain 45,228 photographs	221

Note: The sample contains 1,463 stand-alone sustainability reports disclosed by 221 STOXX Europe 600 companies sample which have continuously been part of the index between January 1st, 2011, and December 31st, 2019.

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data tables, icons, corporate logos, drawings, or cartoons. We also excluded collages because they represent several photographs in one image file. We removed duplicate photographs in each report, in order to ensure that recurring photographs such as a chapter separator, are only included once. The data cleaning process had two steps: first, we applied a 50-kilobyte memory size threshold on all files to exclude the substantial number of corporate logos and icons from the data set. Second, the remaining procedure was based on a semi-automatic process, whereby image files are flagged based on the subject matter identified by Google's computer vision models. Our final data set of photographs consists of 45,228 photographs contained in 1,463 sustainability reports.

3.2 | Classification of Environmental Photographs

Advances in artificial intelligence-powered software and computing resources enable researchers to analyze and draw conclusions from large-scale data sets in an automated way. Computer vision facilitates sophisticated information retrieval from graphic material without having prior knowledge of the presented inputs. It allows for the analysis of much larger data sets than previously feasible and ensures high consistency in the assessment of photographic content. Apart from open-source frameworks, there are several commercial providers of pre-trained computer vision solutions, which do not require additional training of the software. In our study, we use Google's Vision API, which can be accessed through its cloud computing infrastructure (Google LLC, 2023) and has been employed in many scientific projects (Chen & Lin, 2014; Nanne et al., 2020). Our approach, which we outline below, is in part similar to the protocol for analyzing graphic material on web pages outlined by Araujo et al. (2020).

To analyze the photographic data set, we deploy Google's label detection feature to retrieve the photograph content by assigning labels. The photographs are thus tagged with up to 10 descriptive labels, as well as a corresponding confidence score for each label ranging between 0 and 1. We performed the data labeling in April 2022. In total, the data set of 45,228 photographs were tagged with 452,004 labels, of which 3,059 are unique values. To classify whether photographs depict environmental subject matter, we developed a codebook based on the list of unique labels assigned by the machine. Two researchers jointly coded the labels, as to whether they unequivocally indicate that the photographs display an environmental theme. We defined labels indicating nature scenes, animals, or renewable energy projects as environmental themes. Furthermore, we only included labels that unambiguously indicate that the relevant object is depicted in the photograph. Hence, we do not consider labels that indicate objects that are very likely present alongside the relevant object, e.g., 'Shepherd', who is likely present along a sheep flock. Also, we excluded labels that have a double meaning, e.g., a 'Python' may both be a programming language or a snake. Lastly, we excluded the labels 'Sky' and 'Cloud' because they are assigned to too many photographs rendering them too

unspecific. The labels 'Sky' and 'Cloud' may still be assigned to a photograph, but we do not include them in the list of classifying labels. From the initial list of 3,059 unique labels, we classified 472 labels as environmental labels. The environmental labels and their corresponding confidence scores are then used to determine whether a photograph is classified as an environmental photograph. In order to qualify as an environmental image, we stipulate that a photograph has to be equipped with at least one environmental labels with a confidence score of over 0.9 or two environmental labels with a confidence score of over 0.7. This results in 12,462 photographs labeled as environmental photographs representing 27.55% of all photographs in the data set.

3.3 | Quantifying photograph use

To date, there is no broadly accepted measure for assessing photograph utilization in corporate sustainability reporting. Most studies use the sum of photographs to determine the level of photograph utilization, the share of a certain image category (Ali et al., 2021; Chong et al., 2019; Rämö, 2011) or in a further iteration include the size of the photographs into their assessment (García-Sánchez & Araújo-Bernado, 2020; Hrasky, 2012; Invernizzi et al., 2021; Nicolò et al., 2022). However, there are only two groups of authors who calculate photograph utilization against the extent of the report in which they are contained (Anantharaman et al., 2020; Breitbarth et al., 2010). We argue that 20 photographs contained in a 40-page report amount to a substantially different use of photographs than 20 photographs as part of a 100-page report. Thus, we assess the use of photographs against the report corpus measured by the number of pages of the report document. The number of report pages is often referred to as reporting quantity (Arvidsson & Dumay, 2022; Fifka & Drabble, 2012). Accordingly, the use of all photographs as well as specifically environmental photographs is assessed relative to the reporting quantity of the particular report. We call these measures photograph utilization (PUT) and environmental photograph utilization (ENV PUT), respectively. In addition to these absolute measures of photograph use, we calculate environmental photograph use against the number of all photographs contained in the particular report, which we call environmental photograph share (ENV share). In this study, the different measures of photograph use serve as our dependent variables, which are derived below. Overall photograph utilization (PUT) for a particular report is measured against reporting quantity:

$$PUT = \frac{photograph count}{page count}$$
(1)

Environmental photograph utilization (ENV PUT) is equally assessed relative to reporting quantity:

$$ENV PUT = \frac{environmental photograph count}{page count}$$
(2)

The environmental photograph share (ENV share) for a particular report is measured as a share of all photographs contained in the report:

$$ENV share = \frac{environmental photograph count}{photograph count}$$
(3)

3.4 | Regression model specification

The above-derived measures of photograph use serve as the dependent variables. Thus, we construct three regression models to estimate the photograph used in corporate sustainability reports. The independent and control variables which are used in all three regression models are specified below:

$$\begin{split} I: PUT \\ &= BO + B1ENVsensitiveindustry_{i,t} + B2ENVperformance_{i,t} \\ &+ B3SOCperformance_{i,t} + B4GOVperformance_{i,t} + B5SHcountry_{i,t} \\ &+ B6RQ_{i,t} + B7CO2equrevenue_{i,t} + B8ESGreportscope_{i,t} \\ &+ B9ESGcontroversy_{i,t} + B10AvgBoardTenure_{i,t} + B11SIZE_{i,t} \\ &+ B12OPM_{i,t} + \varepsilon_{i,t} \end{split}$$
 (4)

```
\begin{split} \text{II} : & \text{ENV PUT} \\ &= & \text{BO} + \text{B1ENVsensitive industry}_{i,t} + \text{B2ENVperformance}_{i,t} \\ &+ & \text{B3SOCperformance}_{i,t} + \text{B4GOVperformance}_{i,t} + & \text{B5SHcountry}_{i,t} \\ &+ & \text{B6RQ}_{i,t} + & \text{B7CO2equive venue}_{i,t} + & \text{B8ESGreportscope}_{i,t} \\ &+ & \text{B9ESGcontroversy}_{i,t} + & \text{B1OAvgBoardTenure}_{i,t} + & \text{B11SIZE}_{i,t} \\ &+ & \text{B12OPM}_{i,t} + & \varepsilon_{i,t} \end{split} 
\end{split} \tag{5}
\begin{aligned} \text{III} : & \text{ENV Share} \\ &= & \text{BO} + & \text{B1ENVsensitive industry}_{i,t} + & \text{B2ENVperformance}_{i,t} \end{aligned}
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```
+ B3SOCperformance_{i,t} + B4GOVperformance_{i,t} + B5SHcountry_{i,t}
+ B6RQ_{i,t} + B7CO2equrevenue_{i,t} + B8ESGreportscope_{i,t}
+ B9ESGcontroversy_{i,t} + B10AvgBoardTenure_{i,t} + B11SIZE_{i,t}
+ B12OPM_{i,t} + \varepsilon_{i,t}
```

The financial and non-financial data were obtained from the Refinitiv database (Kind et al., 2023; Landau et al., 2020; Refinitiv Inc., 2023). As we argued in Section 2.3, we are interested in identifying the relationships between sustainability performance and photograph use as well as how photograph use varies across industries. These variables serve as independent variables in our regression. The variables ENVperformance, SOCperformance, and GOVperformance denote the three pillar scores which comprise the commonly used Environmental, Social and Governance (ESG) scores by Refinitiv. The more granular pillar scores measure firm performance in the particular sustainability domain. ENVsensitiveindustry denotes whether a company operates in an environmentally sensitive industry. Following Clarkson et al. (2011) and Branco and Rodrigues (2008), we define the Pulp and Paper, Oil, Gas and Coal, Chemicals, Metals and Mining, Construction as well as Building Materials as environmentally sensitive industries given their high pollution propensity. The industry affiliation is in line with the Industry Classification Benchmark (FTSE Russell, 2023).

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In addition, we include several control variables in our regression models. SHcountry indicates whether a company is domiciled in a common law or civil law country. Studies by Fifka and Drabble (2012) and Kolk and Perego (2008) have shown that cultural differences play an important role in explaining differences in how companies approach sustainability reporting. RQ denotes the natural logarithm of the sustainability report's page count as a proxy for the amount of information companies choose to disclose in their reporting. To account for the difference between the environmental sensitivity of the industry in general and the individual greenhouse gas emissions of firms, we include CO2equrevenue measuring the natural logarithm of CO2-equivalent emissions divided by net annual revenue. Furthermore, ESGreportscope incorporates the share of a company's commercial activities covered by its non-financial disclosure. ESGcontroversy is included in our models to control the level of controversy surrounding a company. We perform a natural logarithm transformation for all ESG scores to ensure an approximate normal distribution of the variables. AvgBoardTenure denotes the average tenure of company board members. Lastly, we control for company size, SIZE, measured by the natural logarithm of net annual revenue, as well as operating profit margin, OPM, winsorized at the 1% level. Non-Euro figures are Eurodenominated using the European Central Bank's average exchange rate for the particular reporting period.

'I' and 't' denote firm i and year t. $\varepsilon_{i,t}$ represents the error term. The Hausman test for all models returns that random effects estimators and fixed effects estimators are both consistent. Hence, we proceed with more efficient random effects estimators. Furthermore, we cluster the robust standard errors by economic agent (i) as well as time period (t). The results of our random effects panel regression are shown below. For Model III, stated by equation (6), we impose an additional restriction to consider only reports with at least five photographs (n = 1,185). We argue that, for reports with few photographs, the distribution of the dependent variable would be heavily distorted by a high percentage of extreme values.

4 | RESULTS

(6)

4.1 | Descriptive statistics and correlations

Our sample includes 1,463 separate reports from 221 companies that have continuously been part of the STOXX Europe 600 index of large European companies. Table 2 lists the number of observations by reporting period. The considered firms are based in 15 different European countries, of which the United Kingdom represents the largest segment with 65 sample companies, followed by 31 from France and 30 from Germany (see Table 3). With regard to the industry composition, Table 4 reports the industry segmentation in line with the two-digit codes of the Industry Classification Benchmark (FTSE Russel, 2023). Table 5 shows the descriptive statistics summary, including minimum, mean, median, maximum, and standard deviation values of all continuous dependent, independent, and control variables. Of all considered reports in the data set, 498 (34.04%) were published by

TABLE 2 Number of reports by reporting period.

Year	Number of observations
2011	158
2012	162
2013	156
2014	162
2015	152
2016	147
2017	140
2018	130
2019	133
2020	123

Note: The sample contains 1,463 report observations.

TABLE 3 Number of companies by country of domicile.

Country	Number of observations
Austria	3
Belgium	7
Denmark	7
Finland	10
France	31
Germany	30
Ireland	3
Italy	13
Luxembourg	2
Netherlands	11
Norway	5
Portugal	3
Spain	12
Sweden	19
United Kingdom	65

Note: The sample contains 221 sample companies.

companies from shareholder-oriented countries domiciled in Ireland or the United Kingdom, and 965 from companies located in continental Europe. Considering the industry sensitivity classification, 366 reports (25.02%) were disclosed by companies operating in environmentally sensitive industries. We calculate Pearson's correlation coefficients for all independent and control variables. The strongest correlation between the variables *CO2equrevenue* and *ENVsensitiveindustry* stands at 0.607. The additional test for variance inflation factor (VIF) yields no factor exceeding 2.0. The variable *SIZE* exhibits the highest VIF value of 1.68, 1.76, and 1.90 in Models I, II, and III, respectively. Hence, we see no concern with regard to multicollinearity.

Overall, we find that photograph utilization measured by the sum of all photographs relative to reporting quantity has fallen between 2012 and 2017 by around 13% (see Figure 1). Since 2017, the overall level of photograph utilization has been relatively stable at around

ICB Industry Code	Industry name	Number of observations
10	Technology	9
15	Telecommunications	14
20	Health Care	13
30	Financials	41
35	Real Estate	7
40	Consumer Discretionary	36
45	Consumer Staples	22
50	Industrials	38
55	Basic Materials	15
60	Energy	11
65	Utilities	15

Note: The sample contains 221 companies in total. ICB Industries Codes denote the two-digit industry codes for equities by FTSE Russell (2023).

one photograph for every three report pages. Against this overall trend of falling photograph utilization, the share of photographs conveying environmental themes has steadily increased from 23.12% in 2013 to 31.13% in 2020 (see Figure 2).

4.2 | Regression Results

Table 6 presents the results of random effects regressions as specified in Section 3.4. The F-test for all models is highly significant.

Model I estimates the overall use of photographs against the length of the report. We find that less extensive sustainability reports feature substantially more photographs relative to report length, i.e., an increase in reporting quantity by 10% is associated with a decrease of 0.021 fewer photographs per report page (p < .0001). Controlling for the difference in report length, we also find that reports of continental European companies feature 0.225 fewer photographs per report page than in reports of their UK or Irish peers (p < .0001). Models II and III consider only the use of environmental photographs which are measured against the length of the report (ENV PUT) or as a share of all photographs contained in a particular report (ENV share). The highly significant negative associations between reporting quantity and PUT, as well as the country of domicile and PUT observed from Model I, also hold for environmental photograph utilization. However, these two relationships are not significant for the ENV share measure. With regard to the regressions on the use of environmental photographs, we find that the two main relationships shown below hold equally in both Models II and III.

We report that companies operating in environmentally sensitive industries use substantially more environmental photographs on an absolute level, as well as a share of photographs depicting environmental subject matter. Both correlations are highly significant at the p < .0001 level. Holding all else equal, the share of environmental

	Minimum	Median	Mean	Maximum	Standard deviation	Variable type
PUT	0.00	0.41	0.48	3.87	0.43	DV
ENV PUT	0.00	0.09	0.13	1.57	0.14	DV
ENV share	0.00	0.25	0.27	1.00	0.19	DV
ENVperformance	11.08	78.62	73.96	98.91	17.46	IV
SOCperformance	17.97	77.39	74.56	98.47	15.24	IV
GOVperformance	6.26	66.31	62.95	98.60	21.02	IV
RQ	3.00	69.00	88.09	560.00	69.06	Control
CO2equrevenue	0.01	29.84	232.40	8238.41	650.21	Control
ESGreportscope	2.28	100.00	90.86	100.00	19.91	Control
ESGcontroversy	0.51	100.00	76.01	100.00	32.98	Control
AvgBoardTenure	1.00	5.73	6.31	17.78	2.35	Control
SIZE	151.40	12,897.80	27,586.59	361,936.13	42,463.67	Control
OPM	-85.84	12.01	14.74	185.52	14.00	Control

Note: The descriptive statistics of the continuous dependent and independent variables are shown before logarithmic transformation or winsorizing. The variable types 'DV', 'IV', and 'Control' denote whether a variable serves as a dependent variable, independent variable, or control variable, respectively.



FIGURE 1 Overall photograph utilization. Note: Photograph utilization (PUT) is calculated by overall photograph use relative to reporting quantity for each reporting period.



FIGURE 2 Share of environmental photographs. Note: Share of environmental photographs (ENV share) is calculated by number of environmental photographs relative to overall photograph use for each reporting period.

photographs is 12.4 percentage points higher for firms from environmentally sensitive industries. In absolute terms, the difference amounts to 0.059 environmental photographs per report page. Figure 3 shows the share of environmental photograph use segmented by environmental sensitivity as well as the corresponding confidence intervals at the 95% level. Secondly, we also find that companies with better environmental performance employ a higher share of environmentally themed photographs ($\beta = 0.063$, p < .01). The correlation is equally observed for the use of environmental photographs in absolute terms ($\beta = 0.065$, p < .01).

4.3 **Robustness tests**

To inspire confidence in our results, we performed a number of additional analyses. Despite the fact that the computer vision algorithms provided by Google have been successfully employed in many scientific studies, we wish to emphasize the importance of establishing reliability between our methodology and the subject matter depicted in the photographs. To test the classification formula of environmental photographs (a photograph is tagged with at least: one environmental label with a confidence score of over 0.9 or two environmental labels with a confidence score of over 0.7), we randomly selected a subset of 500 photographs, around 1% of the total data set, for manual validation. To validate the machine-supported visual content analysis approach, three human coders independently assessed a subset of 500 randomly selected photographs. The coders comprised one researcher and two graduate students, who were otherwise not involved in the research project. They were tasked with a binary decision on whether the photograph depicted environmental subject matter or not. The above-proposed formula to classify photographs as environmental photographs has the highest overall agreement with the three human coders. In 82.2% of the cases, the four

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	Model I	Model II	Model III
	PUT	ENV PUT	ENV Share
ENVsensitiveindustry.d	-0.019 (0.044)	0.059*** (0.013)	0.124*** (0.021)
ENVperformance.log	0.048 (0.070)	0.063* (0.023)	0.065* (0.023)
SOCperformance.log	-0.136 (0.078)	-0.031 (0.033)	-0.023 (0.036)
GOVperformance.log	0.007 (0.035)	0.021 (0.014)	0.027 (0.020)
SHcountry.d	-0.225*** (0.053)	-0.062*** (0.013)	-0.010 (0.016)
RQ.log	-0.210*** (0.040)	-0.062** (0.018)	-0.004 (0.016)
CO2equrevenue.log	0.016 (0.007)	0.003 (0.002)	0.001 (0.005)
ESGreportscope.log	-0.015 (0.030)	-0.014 (0.009)	-0.019 (0.013)
ESGcontroversy.log	0.001 (0.014)	0.001 (0.004)	0.001 (0.006)
AvgBoardTenure	0.002 (0.007)	0.004 (0.002)	0.003 (0.002)
SIZE.log	0.026 (0.011)	0.00001 (0.003)	-0.008 (0.005)
OPM.win	-0.00004 (0.001)	0.0002 (0.0005)	0.001 (0.0004)
Constant	1.463*** (0.352)	0.214 (0.095)	0.153 (0.103)
Observations	1,397	1,397	1,185
R ²	0.178	0.143	0.079
Adjusted R ²	0.171	0.136	0.069
F Statistic	254.464***	208.923***	75.176***

TABLE 6 Result of random effects regressions.

Note: Model III includes only reports with at least five photographs resulting in a 15.17% smaller sample set of n = 1.185. Robust standard errors are stated in parentheses. Significance levels are denoted as follows: ***p < .0001. **p < .001. *p < .01. In model I the independent variables SIZE and CO2equrevenue are additionally significant at the 5% level. Suffices 'log', 'd', and 'win' denote transformation by natural logarithm, a dummy variable, and winsorization at the 1% level, respectively.



FIGURE 3 Share of environmental photographs by industry sensitivity. Note: Black graph denotes the average ENV share value of reports issued by companies from environmentally sensitive industry (N = 366). Grey graph denotes the average ENV share value of reports issued by firms operating in non-environmentally sensitive industries (N = 1097). Dotted graphs denote the corresponding confidence intervals at the 95% level.

coders unanimously agreed on whether or not a photograph depicted environmental subject matter. Notably, we found that the level of agreement among human coders is no higher than between human coders and the label-based coding approach. For intercoder reliability, we report Krippendorff's α of 0.757 (Krippendorff, 2018).

Nevertheless, we are convinced of the accuracy of our proposed formula and the vision models' general capacity to ascribe appropriate labels. We found that small changes to confidence score thresholds considerably change the total number of photographs classified as environmental photographs. Thus, we computed several alternative formulas to compare how these might affect the results of the regression estimations of Models II and III. We focused on edge cases, which substantially deviate from the main formula classifying 12,462 photographs as environmental photographs. Below, three alternative classification criteria are listed with the corresponding total number of environmental photographs in parentheses: i) photographs with an environmental label independent of the confidence score [16,080], ii) photographs with at least three environmental labels with corresponding confidence scores of over 0.7 [7,830], and iii) photographs with at least one environmental label with a corresponding confidence score of over 0.95 [5,435]. The resulting total number of photographs for the alternatives listed deviates markedly from the base case of 12,462 environmental photographs. The total number of environmental photographs for the first alternative increases by 29.0% against the base case, while the count in the second and third alternatives shrinks by 37.2% and 56.4%, respectively. To assess the robustness of our regression outcomes, we computed Models II and III with the alternative sets of environmental labels. However, across all computed alternatives, the main effects and their algebraic signs scarcely change in spite of material changes to the number of photographs categorized as environmental photographs. The explanatory variable

environmental sensitivity remains significant at least at the 0.1% level across all computed alternatives for both regression models. The significance level of the environmental performance variable varies but meets the threshold of 5% in each alternative estimation.

Furthermore, we estimated our regression models with several other control variables not included in the presented models. These include controls for financial and non-financial variables, e.g., market capitalization, ownership structure, or the existence of a sustainability assurance provider, as well as sector dummies for sin industries, such as alcohol, tobacco, or gambling (Dhandhania & O'Higgins, 2022), and proximity to the final consumer. In addition, we estimated our regression models with several alternative definitions of environmentally sensitive industries which did not materially alter the regression estimations. As reported in Section 3.4, the estimation of Model III is restricted to reports with at least 5 photographs. Hence, we also ran the regression Models I and II with the same restrictions but did not find substantial differences in the observed effects. We further tested the robustness of the findings by running Ordinary Least Squares regression with all models, which yielded consistent results. Moreover, all regression estimations were run with clustered standard errors, as reported in Section 3.4, leading to more reliable standard error estimations.

With the additional analyses described above, we seek to address endogeneity concerns, which may be caused by measurement errors or omitted variables. While our methodology yields very robust and reliable results, we cannot claim a causal link between the observed relationships. However, we believe that it is more likely than not that the effect directions run from the independent to the dependent variables. In particular, the correlations between ENVsensitiveindustry and the two measures of environmental photograph use are very unlikely to suffer from reverse causality. On the other hand, we believe endogenous sample selection to be more material. In the sample selection process, we decided to only include separately disclosed sustainability reports to unequivocally attribute every photograph to a company's sustainability disclosure. While we believe that this decision was necessary, it may have introduced some selection bias as the choice of reporting format is self-selected by the company. Moreover, membership in the STOXX Europe 600 index includes only listed companies, which tend to be larger than their non-listed peers. While we cannot entirely eliminate endogeneity concerns, we believe that our study yields very robust results in spite of sizeable changes to the methodology.

DISCUSSION 5

5.1 **General Discussion**

The study set out to systematically examine photograph use in corporate sustainability reporting. We intentionally chose an explorative approach to guide our research. We introduced a novel methodology to assess photographic content, thereby facilitating the assessment of large-scale data sets. Our three main findings are discussed below.

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Firstly, for overall photograph utilization (PUT) across our sample, we report a falling trend, which stabilizes at around 0.33 photographs for each report page after 2017. An alternative measure, employing the median PUT value in a given year yielded a fairly stable trend centered around 0.4 photographs per page. Nevertheless, the general belief that sustainability reports are ever more densely filled with photographs was not confirmed. Our results are even more intriguing as the cost of printing and distributing photograph-rich reports has all but evaporated since the report documents are primarily shared digitally. The increasing prevalence of photographs observed by several other studies (Ali et al., 2021; Anantharaman et al., 2020; Beattie et al., 2008; Chong et al., 2019) may be due to differences in sample selection, different measures for photograph utilization and/or study period. On the other hand, the study by García-Sánchez and Araújo-Bernado (2020) also reports some evidence that the overall use of photographs is trending downward. Comparing among studies that assess photograph utilization in the same way, other authors report notably higher values of photograph utilization, ranging from 0.57 (Invernizzi et al., 2021) to around 1.03 (Anantharaman et al., 2020). Irrespective of the direction of the trend, which might be driven by sample selection, our results underscore that photographs remain an integral element of the reporting toolbox and feature on approximately every third reporting page across our study sample. This finding is in line with several other studies in the field (Boiral, 2013; Breitbarth et al., 2010; Zeng et al., 2022). We confirm the assessment by Davison and Warren (2009) that photographs remain a heavy weight ingredient of corporate sustainability reporting. In spite of the substantial variance in the photograph density measured by PUT, the observed negative relationship between reporting quantity and photograph utilization is substantial and highly statistically significant. This indicates that shorter sustainability reports are on a lengthadjusted basis much more densely filled with photographs. Hence, companies that are less forthcoming choose to dedicate more visual elements to communicating sustainability-related disclosures. While we cannot establish an exact link between report length and the amount of information disclosed, a higher number of photographs leaves on average less room for textual or numerical information, which suggests a preference for conveying more non-standardized and hard-to-compare information through photographs. This is partly supported by Anantharaman et al. (2020), who report that higher use of photographs is negatively associated with the number of topics covered in the sustainability report.

Secondly, the strong positive relationship between the use of environmental photographs and the environmental sensitivity of the industry sector is observed for both ENV share and the ENV PUT. The relationship between ENVsensitiveindustry and the ENV share indicates that firms with environmentally sensitive business models use a substantially higher share of all photographs to convey the environmental subject matter. Similarly, companies fill their sustainability reports more densely with environmental photographs relative to the length of the report corpus (ENV PUT). Both associations are highly significant at the 0.01% level. This suggests companies from environmentally sensitive industries have a strong preference for communicating

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environmental messages through visual elements, which remained stable throughout the entire study period. Thus, these companies choose to give more space to pictorial communication of environmental subject matter, resulting in an increased visual presence of such themes. Companies make outsized use of the visual realm to transmit environmental information, which is by definition non-standardized and hence often difficult to verify or compare. This finding is in line with legitimacy theory (Suchman, 1995) stating that companies that cannot achieve moral legitimacy through responsible business conduct may try to attain it by shaping the perception of their stakeholders through their sustainability communication (Cho & Patten, 2012). Companies with sensitive business models would be expected to establish their legitimacy through reporting, in which visual imagery plays an important role in protecting their image as legitimate undertakings (Breitbarth et al., 2010; Hummel & Schlick, 2016). Symbolic environmental disclosure may thus help to avoid detrimental effects on the organization's legitimacy in the eyes of society (Ashforth & Gibbs, 1990; Guthrie & Parker, 1989; Rezaee. 2016). Related studies similarly find that companies that are less motivated by sustainability pursue a more symbolic approach reporting their sustainability matters (García-Sánchez & to Araújo-Bernado, 2020; Hrasky, 2012) and tend to disseminate qualitative information that is not easily subject to comparison (Cho & Patten, 2012; Hummel & Schlick, 2016; Patten, 2002). However, the relationship between the use of environmental photographs and ENVsensitiveindustry does not extend to the overall use of photographs. As shown in regression Model I, we did not find a significant correlation between overall visual disclosure and operating in an environmentally sensitive industry, as reported by Anantharaman et al. (2020) and Nicolò et al. (2022). Thus, we only observe a preference among companies from environmentally sensitive industries to use a higher share of photographs to disseminate environmental themes. In a related domain, Lock and Araujo et al. (2020) report a different strategy regarding photograph use, whereby companies with environmentally sensitive business models visually highlight social themes in order to draw attention away from environmental topics. When comparing existing studies, the share of environmental photographs reported across the entire sample is very similar to the levels found by Boiral (2013) and Rämö (2011). The findings of Invernizzi et al. (2021), showing a low share of environmental photographs in the non-environmentally sensitive health care industry, is in line with our results. Moreover, the observations by García-Sánchez and Araújo-Bernado (2020) and Hrasky (2012) that companies that are less motivated by sustainability, use a more symbolic approach to photograph use, is also confirmed by our study.

Thirdly, we find a positive association between environmental performance and the use of environmental photographs, which is observable for both measures: *ENV share* and *ENV PUT*. These relationships indicate that companies seem to signal their stronger environmental credentials through a higher absolute use of environmental photographs as well as a higher percentage of all photographs contained in a particular report. Both measures of environmental photograph use are significant at the 1% level. These findings are in line with voluntary disclosure theory and, by extension, signaling theory. According to these theories, superior performers visually signal their

superior outcomes to stakeholders (Mahoney et al., 2013), while inferior performers might choose to disclose less information (Clarkson et al., 2008). Thus, firms with good environmental credentials choose to emphasize environmental themes to profit from the comparison with their peers in this domain (Connelly et al., 2011; Rezaee, 2016). Similar to Hummel and Schlick (2016), our results are supported by both voluntary disclosure theory and legitimacy theory. However, the effect size of industry affiliation as observed in the regression results is much larger than the relationship between environmental performance and environmental photograph use.

In addition, the observed relationship between photograph utilization and the firm's country of domicile may be explained by cultural or socio-economic factors within those countries, as reported by Fifka and Drabble (2012). The preference of firms located in common law countries, e.g., the United Kingdom and Ireland, for publishing reports that are much more densely filled with photographs as well as environmental photographs, compared to those of their continental European peers, is highly significant. Notably, this relationship does not extend to the share of environmental photographs contained in a particular report.

5.2 | Implications

In this study, we introduced a novel approach to analyzing photograph use in corporate sustainability reports. Our findings have theoretical and practical implications. The theoretical implications are two-fold.

Firstly, our novel machine-supported approach facilitates the analysis of substantially larger photograph datasets, thereby producing more robust findings with higher generalizability. This extends to providing new avenues for fellow researchers interested in studying photographs or other visual elements within the realm of corporate reporting. In addition, we underscore the importance of assessing photograph use against the report corpus in which they are contained, as we have observed a strongly negative relationship between reporting quantity and photograph density.

Secondly, the empirical results of this study extend the scientific discussion about corporate sustainability reporting practices. In a field of research that lacked studies with both longitudinal data and cross-sectional variation, we contribute to the understanding of photograph use. Our findings challenge the existing beliefs on photograph use, showing instead that sustainability reports have become less densely filled with photographs over the last decade. Furthermore, we find that companies operating in environmentally sensitive industries do not use more photographs overall but choose to select a significantly higher percentage of environmentally themed photographs. In addition, we make the novel observation that there is a positive relationship between environmental performance and environmental photograph use.

Moreover, our findings also have practical implications. Given the contested nature of corporate sustainability, the reporting behavior we observe in our study offers reason for caution. The strong and sustained preference of companies with environmentally sensitive business models to disseminate non-comparable environmental information through photographs is of particular concern. The misalignment between the operational reality of companies with environmentally sensitive business models and the observed visual reporting practices should be concerning to all stakeholders interested in sound reporting practices. The overrepresentation of environmental motives on the visual level may create an unsubstantiated positive perception, which contrasts with the operational reality of companies in environmentally sensitive industries. Our study has practical implications for three relevant stakeholder groups, namely, readers of corporate sustainability reports, managers, and regulators.

Readers of corporate sustainability reports may be advised to be very clear-eyed about corporate sustainability disclosure. These include both professional stakeholders, such as investors or analysts. as well as non-professional stakeholders, e.g., employees or societyat-large. The diverse readership of corporate sustainability reports reinforces the problem as non-professional stakeholders lack the means to evaluate claims made therein (Belal & Cooper, 2011; Gugerty, 2009). As the content of photographs cannot easily be compared or verified, they may be used to camouflage negative performance (Cho et al., 2010; Mahoney et al., 2013) or divert attention from adverse information (Arora & Lodhia, 2017; Boiral, 2013), and pose the risk of reducing corporate transparency thus (Hopwood, 2009). As photographs exert more influence than text alone, they can have an outsized impact on readers' issue perception (Zillmann et al., 1999). Because readers do not examine the report in its entirety (Unerman, 2000), the substantial length of sustainability disclosure increases even further the likelihood of readers being drawn to more favorable sections of the report.

For managers, we advise using photographs with caution. While we have scant evidence of how photographs in sustainability disclosure impact readers, related studies indicate that photographs can be effectively used to sway their opinions (Townsend & Shu, 2010; Zillmann et al., 1999). We recommend that all visual communication, including photographs, is provided with detailed explanations to avoid misinterpretation and ensure accurate and balanced sustainability reporting.

For regulators, who are tasked with evaluating managerial discretion in designing sustainability reports and guarding the integrity and credibility of corporate disclosure, the gap between perceived and communicated reality is hard to square with the general principle of balanced reporting. This may then require revisiting the amount of managerial discretion over the design of their sustainability reporting. The somewhat uncertain regulation of sustainability disclosure may even induce managers to make full use of their reporting discretion (Higgins et al., 2020; Lyon & Montgomery, 2015; Meng et al., 2013; Wedari et al., 2021).

6 | CONCLUSION

The objective of this empirical study was to introduce a novel approach to assess photograph use in corporate sustainability reporting and to provide evidence of environmental photograph utilization by European companies. To the best of our knowledge, ours is the first large-scale empirical analysis in the field using a machinesupported content analysis approach. We add to a growing body of literature around corporate sustainability reporting and shed light on a major but insufficiently understood element of sustainability reporting. This study makes two novel contributions: Firstly, we propose a new methodological approach to assessing visual communication in corporate reporting, which allows for the analysis of large-scale data sets. Secondly, we offer empirical evidence to a scientific discussion that previously lacked studies with both longitudinal data and crosssectional variation. Our results show that contrary to conventional wisdom, photograph utilization in corporate sustainability reports has decreased over the last decade. Somewhat in line with existing studies, we find that companies operating in environmentally sensitive industries do not use more photographs overall but choose to select a significantly higher percentage of environmentally themed photographs. On the other hand, accounting for the effect of operating in an environmentally sensitive industry, we observe a positive relationship between environmental performance and environmental photograph use. This finding indicates, contrary to the results of existing studies, that companies with strong environmental credentials signal their green performance through higher use of environmental photographs.

Our study has inherent limitations due to its design and methodology. By using a machine-supported visual content analysis approach, we trade off the size of our data set against the precision of measurement. We also recognize that our measure of photograph utilization does not account for the size or position of a photograph in a report. While our methodology yields very robust and reliable results, we cannot claim a causal link between the observed relationships. Going forward, we see great benefits in approximating the causal effects of photograph use on readers' issue perception. Moreover, future research could extend to the process and managerial rationale for including photographs in sustainability reports. Given the welldocumented potency and prevalence of photographs, we strongly encourage further research on their role in corporate sustainability reporting. Coinciding with the introduction of the Corporate Sustainability Reporting Directive (European Parliament & European Council, 2022), our contributions to photograph use should allow for a more complete assessment of sustainability reporting practices.

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