Global Evolution of Environmental and Social Disclosure in Annual Reports*

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Global Evolution of Environmental and Social Disclosure in Annual Reports

Abstract

We study environmental and social (E&S) disclosures in annual reports. Using the word embedding model to examine over 210,000 annual reports from 24,271 public firms in 30 international countries/regions between 2001 and 2020, we create an E&S dictionary that allows us to document trends in annual report E&S disclosure. Specifically, we find: 1) increases in length and boilerplate language, and 2) decreases in specificity. Our results also suggest that E&S disclosure quality improves after the adoption of voluntary ESG reporting frameworks but deteriorates after disclosure mandates. Our findings provide systematic evidence on the evolution of E&S disclosure in annual reports over the past two decades and shed light on how voluntary and mandatory standards have shaped global E&S reporting practices.

Keywords: ESG disclosure, Nonfinancial information, Textual analysis, Machine learning

JEL Classifications: G15, G38, M14, M40, M48

1. Introduction

In the past two decades, environmental and social (E&S) considerations have become increasingly integral to investment decisions, and more and more publicly listed firms have begun to provide E&S disclosures. Meanwhile, dozens of ESG reporting standards and frameworks have emerged and many jurisdictions have either encouraged firms to adopt certain voluntary reporting frameworks, or have issued (or are in the process of issuing) mandatory E&S disclosure regulations.[1] At the same time, regulators and standard setters have started to cooperate and consolidate their efforts around E&S disclosures, which may lead to substantial changes in the E&S disclosure landscape.[2] Against this backdrop, understanding the pathways to the current state of E&S disclosure and assessing the roles that ESG reporting frameworks and mandates have played in reaching this state could lead to better policies and practices in the future (Leuz, 2018). Despite the topic's clear importance, the extant literature provides almost no large-sample empirical analysis of the global evolution of E&S disclosure over the past two decades. Our goal in this paper is to provide the first systematic large-sample evidence on E&S disclosure. To do this, we examine over 210,000 annual reports, published between 2001 and 2020, from 24,271 public firms across 30 countries/regions (hereafter, "countries").

In our study, an annual report refers to a comprehensive document published by a publicly traded firm each year to inform shareholders and other stakeholders about the firm's

[1] ESG stands for Environmental, Social, and Corporate Governance, and refers to the three key areas in which socially responsible investors evaluate the sustainability and societal impact of a firm and its business activities (see MSCI 2022a). We focus on environmental and social disclosure only, and do not study governance disclosure because prior literature has provided extensive evidence on corporate governance disclosure.

[2] For example, the International Integrated Reporting Council (IIRC) and the Sustainability Accounting Standards Board (SASB) have officially announced their merger to form the Value Reporting Foundation (IAS Plus, 2021). As another example, the IFRS Foundation and Global Reporting Initiative (GRI) have agreed to coordinate their standard-setting (GRI, 2022).

operations and financial performance.[3] It contains a wide range of information, such as financial statements, discussions of the previous year's activities, and plans for the coming year(s). E&S disclosure is often included in annual reports to provide insights into the sustainable value creation of the firm. To gain a more complete picture of the global evolution of E&S disclosure in annual reports, we develop measures to characterize both the quantity and quality of E&S disclosure across five dimensions: 1) the length of E&S disclosure, 2) the use of boilerplate language, 3) the specificity of E&S disclosure, 4) the stickiness of E&S disclosure for the same firm over time, and 5) the use of visual cues. Moreover, we provide evidence on how voluntary reporting frameworks and mandatory regulations have contributed to these E&S disclosure attributes. Our study focuses on E&S disclosure in annual reports instead of stand-alone ESG reports because most countries have chosen to mandate integrated E&S reporting in annual reports rather than requiring standalone ESG reports.[4]

Despite the centrality of annual reports to corporate reporting and disclosure, there is limited research examining E&S information disclosed in annual reports. This is due partly to the range of complex topics that fall under the E&S umbrella, and partly to the challenges of extracting and quantifying E&S disclosures from full-text annual report data. We collect the annual reports of publicly listed firms within 30 countries through *Refinitiv Global Filings* (RGF) (see Table 1 Panel B for the list of countries). Unlike most prior ESG studies, which typically rely

[3] Consistent with this definition, the *Refinitiv Global Filings* (RGF) database considers a document as a valid annual report if it contains a discussion of the company's financial conditions and operations over the previous year, as well as the full set of financial statements and related notes audited by an authorized entity (Balance sheet, Income statement, and Cash Flow Statement).

[4] In addition, certain data constraints have led us to focus on E&S disclosure in annual reports. First, it is hard to conduct an "apples to apples" comparison for E&S disclosures in different filings, such as annual reports vs. standalone reports. Second, annual reports of public firms are readily available, allowing us to compare the same firms over time. In contrast, standalone reports are often rare until a country has specifically mandated ESG reports. Based on the RGF database, less than 4% of the firm-year observations in our sample are accompanied by standalone ESG reports.

on human-based ratings, commercial textual analysis software, and/or proprietary ESG databases to measure E&S disclosure (e.g., Blacconiere and Patten 1994; Chen and Bouvain 2009; Krueger et al. 2024), this study uses a natural language processing technique called word embedding to create an E&S dictionary to quantify E&S disclosure. This technique overcomes the challenges of relying on human experts to manually inspect thousands of annual reports and helps us create an E&S dictionary that covers a wide range of multidimensional and evolving topics.

To create an E&S dictionary, we first select a set of seed words that fall into seven Environmental (E) and Social (S) subtopics found in six major voluntary ESG reporting frameworks.[5] These subtopics include Climate Change, Natural Resources, Pollution & Waste, Ecosystem, Human Capital, Products & Customers, and Other Stakeholders (See Table 2 for details). We then apply the word embedding technique to expand these seed words into a comprehensive E&S dictionary (see Table OA.1). We use 15 human raters to validate our machine-generated E&S dictionary in a sample of 140 E&S and non-E&S sentences selected from annual reports. The average kappa statistic of 0.9 indicates a significant overlap between human- and machine-identified E&S disclosures, suggesting that our approach can accurately extract relevant E&S information from annual reports.

After generating and validating the E&S dictionary, we develop empirical measures to assess both the quantity and quality of corporate E&S disclosure. First, we calculate the quantity

[5] The six voluntary reporting frameworks include the Carbon Disclosure Project (CDP), the Climate Disclosure Standards Board (CDSB), the Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC), the Sustainability Accounting Standards Board (SASB), and the Task Force on Climate-related Financial Disclosures (TCFD). CDP is different from the other five organizations in that its standard is questionnaire-based and the resulting corporate ESG information is only available in the CDP database rather than in firms' own reports. For the sake of simplicity, we consider CDP equally with the other five frameworks in this study.

of E&S disclosure in an annual report by measuring the length of overall E&S disclosure, as well as the disclosure length for each subtopic. Second, we measure E&S disclosure quality using a set of variables that capture distinctive textual attributes. These variables include 1) the occurrences of generic language in E&S disclosure, measured as the percentage of E&S-related sentences containing boilerplate phrases (Lang and Stice-Lawrence 2015); 2) the specificity of E&S disclosure, defined as how often E&S-related text refers to specific people, places, organizations, times, or numbers (Hope, Hu, and Lu 2016); 3) the stickiness of E&S disclosure for the same firm over time, measured by the degree of similarity in a firm's E&S disclosures year-over-year; and 4) the occurrence of visual cues in E&S disclosure, calculated as the number of infographics provided alongside an E&S disclosure narrative (Christensen et al. 2024).

Prior studies suggest that various country- and firm-level factors explain the variation in E&S disclosure attributes. Hence, we first explore a set of cross-sectional attributes that can be potentially associated with such variation in E&S disclosure, which offers us a baseline model for our later tests. Consistent with prior literature (Cowen, Ferreri, and Parker 1987; Chan, Watson, Woodliff 2014; Baldini et al 2018), we find that the length of E&S disclosure is positively associated with analyst coverage, institutional ownership, and size. This finding further supports the validity of our measures. In addition, coverage by ESG rating agency and issuance of standalone ESG report are both associated with longer and higher quality E&S disclosure in annual reports. Moreover, we document that several environmental and social factors that likely reflect a country's awareness of E&S issues (e.g., usage of renewable energy, percentage of females in the labor force, life expectancy) are positively associated with the quantity and/or quality of E&S disclosure. Overall, E&S disclosure appears to be primarily a firm-level decision rather than one that is shaped by country-level factors, as adding firm characteristics and firm fixed effects significantly improves the explanatory power of our model.

Our main research question focuses on the global evolution of E&S disclosure from 2001 to 2020. After controlling for the overall textual and visual characteristics of annual reports and other disclosure factors in our baseline model, we document a significant upward trend in E&S disclosure length and a positive but statistically insignificant trend in related infographics in annual reports. However, we also find that firms use more generic language and provide less specific information in E&S disclosures over this timeframe, calling to mind practitioners' concerns about the usefulness of E&S disclosure (e.g., SASB 2017; GAO 2020). These marked trends appear in all five Fama-French industries, and hence are not industry specific. Our findings imply that E&S disclosure quality is not necessarily improving as the practice of E&S reporting matures.

In addition, we explore changes in the E&S subtopics mentioned in annual reports during our sample period and find that disclosure related to climate change and human capital has drastically increased relative to the other subtopics. We further document how the most frequently used E&S vocabulary in annual reports has evolved over time (i.e., 2001-2005 vs. 2016-2020). Specifically, issues pertaining to energy efficiency, greenhouse gases, discrimination, and carbon have become more frequently discussed, while topics related to product quality and customer service have become less common in recent years.

Lastly, we rank the average length of E&S disclosure by country and plot the changes in rankings over the course of our sample period (i.e., 2001-2005 vs. 2016-2020). Our descriptive evidence shows that several countries in Asia (e.g., Indonesia, Hong Kong, China, Japan,) climb the most in our ranking. In contrast, several European countries (e.g., Denmark, Sweden, and Russia) are among those showing significant decline in the relative ranking, although the absolute amount of E&S disclosure has also grown significantly for firms in these countries during our

sample period. This result suggests that E&S disclosure practices are still in the development stage for most economies in our sample.

Our second research question examines whether voluntary reporting frameworks and mandatory disclosure regulations have contributed to the changing landscape of E&S disclosure. In the voluntary disclosure domain, six major ESG reporting frameworks, including CDP, CDSB, GRI, IIRC, SASB, and TCFD, emerged during our sample period. By identifying sentences in annual reports that mention the name(s) of these frameworks, we document that the percentage of firms in our sample that have adopted voluntary ESG reporting frameworks has increased from zero to over 20% in the last two decades, primarily driven by the rising popularity of GRI and TCFD.[6] We further investigate whether the adoption of voluntary reporting frameworks is associated with any disclosure changes. We find that, when voluntary reporting frameworks are used, annual reports include more E&S disclosure that uses less generic language, contains more infographics, and exhibits higher disclosure stickiness.

In the mandatory disclosure domain, 23 out of our 30 sample countries have issued E&S disclosure mandates during the period from 2001 to 2020 (see Online Appendix B Panel B). Among these 23 countries, 19 have issued multiple E&S disclosure mandates. For each country, we carefully examine the disclosure requirements of each mandate and identify the mandate with the earliest effective date (hereafter, the first E&S disclosure mandate), as well as the one with the most comprehensive E&S disclosure requirements (hereafter, the most comprehensive E&S disclosure mandate) in our sample period. As we discussed in Section 4.4, we do not observe significant changes in E&S disclosure characteristics following the first mandate. In contrast, we

[6] Note that the estimated increase in the adoption of voluntary ESG reporting frameworks might be rather conservative because firms may not always state which framework(s) they have adopted and there are some other frameworks not included in our search.

find that firms indeed provide more E&S disclosures subsequent to the most comprehensive mandates. Moreover, we document that E&S disclosure becomes more generic, less specific, and stickier following the most comprehensive mandates. Together, our findings suggest that the overall effects of existing E&S disclosure mandates are primarily manifest in the quantity rather than the quality of E&S reporting. There are two possible explanations for this result. First, firms that do not voluntarily report E&S information are forced to adopt E&S disclosure by mandates. Hence, they lack reporting incentives and tend to provide low-quality disclosures. Second, firms that have already voluntarily reported E&S information may also lower disclosure quality following the mandates because there is less differentiation when all firms are forced to report. We explore these explanations in our additional analysis (see Table OA.7) and identify this as an area for future research.

This study makes several contributions to accounting literature. First, to our knowledge, this is the first study to systematically examine the textual and visual attributes of annual report E&S disclosure in a large sample of international firms over a period of twenty years. Our research complements the existing literature on the determinants and economic consequences of E&S disclosure (e.g., Gibbons 2023; Krueger et al. 2024; see Christensen, Hail, and Leuz 2021 for a detailed review). We identify clear trends in E&S disclosure attributes. While the fact that E&S disclosure has increased over time is not surprising, we provide new insights by documenting significant changes in several proxies (e.g., boilerplate; specificity) that potentially suggest a deterioration in the quality of E&S disclosure. We further document that E&S disclosure quality increases following the adoption of voluntary ESG reporting frameworks. To some extent, this result is subject to endogeneity because firm-level reporting incentives could drive voluntary disclosure decisions. In contrast, some attributes associated with E&S disclosure quality deteriorate after regulators tighten mandatory disclosure requirements.

Second, our study provides academic researchers with a comprehensive tool (i.e., a dictionary) for measuring and evaluating E&S disclosure. Most prior literature relies on human raters, commercial textual analysis software, or proprietary ESG databases to measure E&S disclosure (e.g., Blacconiere and Patten 1994; Chen and Bouvain 2009; Krueger et al. 2024). However, such disclosure measures are subject to several limitations, including high implementation costs in large samples and lack of transparency and comparability (LaBella et al. 2019; Freiberg et al. 2021). In contrast, our approach offers a set of important empirical measures that captures the quantity and quality of E&S disclosure. Future research in the field of E&S disclosure can directly adopt our dictionary or easily expand it using a new corpus. Also, our study provides a baseline of voluntary E&S disclosure practices for future studies on the effects of new mandatory E&S reporting regulations post-2020.

Finally, our empirical analyses support evidence-informed policymaking related to matters of ESG reporting. For example, many regulators across jurisdictions are still in the process of establishing (e.g., the SEC) or expanding (e.g., the EU) requirements for firms to disclose E&S information in their annual reports or other filings (Deloitte 2021). Our findings of increasing boilerplate language and decreasing specificity in E&S disclosure reaffirm the urgency of strengthening disclosure quality.

2. *Methodology*

2.1. LITERATURE ON ESG DISCLOSURE MEASURES

There is a growing literature on ESG reporting in the fields of accounting and finance. The bulk of this literature studies the economic consequences of ESG reporting or related disclosure regulations (see Christensen et al. 2021 for a comprehensive review). In this section, we review the literature with a focus on the empirical measures used as proxies for disclosure of E&S-related

information. The existing E&S disclosure measures used in prior studies largely fall into four categories.

First, many early studies rely on humans to manually code the scope of E&S disclosure using certain criteria developed by the researchers themselves (e.g., Abbott and Monsen 1979; Belkaoui and Karpik 1989; Blacconiere and Patten 1994; Cormier and Magnan 1999; Cormier and Magnan 2003; Cormier, Magnan, and Van Velthoven 2005; Bouten, Everaert, and Roberts 2012). For example, Blacconiere and Patten (1994) develop a coding scheme to measure the presence or absence of statements in five areas of environmental concern, resulting in a score ranging from zero to five. This method is labor-intensive and likely cannot be applied to a large sample. As a result, most studies using hand-coded E&S disclosure measures sample only a few hundred firms.

Second, a few studies use commercial textual analysis software to analyze the content of E&S disclosure and construct E&S disclosure measures (e.g., Chen and Bouvain 2009; Tate, Ellram, and Kirchoff 2010; Nishant, Goh, and Kitchen 2016). For example, Chen and Bouvain (2009) rely on Leximancer, a proprietary content analysis package, to identify major themes discussed in CSR reports and assess the relative importance of these themes. While viable, one of the many limitations of these software packages is that they rely on proprietary algorithms that are not publicly available to researchers.

Third, some recent studies rely on measures provided by commercial ESG data vendors such as GRI and Bloomberg. For example, Krueger et al. (2024) study the effect of ESG disclosure mandates on ESG disclosure quality using the GRI compliance index, an indicator variable for whether a firm has filed an ESG report in the GRI database. Similarly, other studies rely on Bloomberg disclosure scores as proxies for the quality of ESG reporting (e.g., Eccles, Serafeim, and Krzus 2011; Utz and Wimmer 2014; Qiu, Shaukat, and Tharyan 2016). These readily available disclosure measures are subject to a few limitations. For example, it is often costly for researchers

to obtain access to these databases. Moreover, since commercial data vendors rarely reveal how their disclosure measures are constructed, there is a lack of transparency and comparability across different data vendors (LaBella et al. 2019; Freiberg et al. 2021). Further, the coverage of these commercial databases is often limited.

Lastly, two contemporaneous papers also apply machine learning techniques to analyze E&S disclosure (Bingler et al. 2022; Abraham, Olbert, and Vasvari 2024). Bingler et al. (2022) develop a deep natural language model called ClimateBert to analyze the intensity of climate risk disclosures for 818 TCFD-supporting firms. Abraham et al. (2024) adopt a textual analysis learning algorithm to identify ESG-related information from private equity firms' websites. Unlike these contemporaneous papers, we study E&S disclosure in a large sample of international annual reports and do not focus on a specific industry or subtopic.

In this study, we adopt an open-source machine learning technique to quantify corporate E&S disclosure using publicly available annual reports. Moreover, unlike prior research, our study provides insight into various attributes of E&S disclosure (e.g., length; boilerplate; specificity; stickiness; visual cues) for a comprehensive set of environmental and social topics. Therefore, our study provides a broader view of the E&S reporting landscape, and future research can easily adopt the methodology we used to quantify E&S disclosure.

2.2. MEASURING E&S DISCLOSURE USING WORD EMBEDDING

Counting the occurrence of terms from word lists (i.e., dictionaries) that share common meanings has been the conventional approach to processing large amounts of textual data and extracting context-specific information (see Loughran and McDonald, 2016). However, our current setting makes it challenging to rely on human experts to manually inspect and categorize words and generate a dictionary for several reasons. First, because E&S-related activities are characterized by a wide-ranging, multifaceted set of topics, E&S disclosure involves numerous

technical terms and much scientific jargon. It often includes highly specific words, abbreviations, and phrases that only apply to a particular domain.[7] Hence, it is difficult to find experts with the broad and deep technical and scientific domain knowledge necessary to identify all relevant E&S terms. Second, relevant words and phrases may enter and leave the E&S lexicon quite rapidly as E&S-related technologies and activities continue to develop and evolve. Thus, it is unrealistic to expect experts to regularly acquire new knowledge to align with the constant shifts in E&S topics. Finally, to measure E&S disclosure as a multidimensional construct, we need to classify E&S-related words and phrases into multiple interrelated categories. The boundaries of these categories may be ambiguous and subtle; therefore, it is a complex and nuanced task for humans to categorize each word or phrase in an objective and consistent fashion. In summary, it is impractical and cost ineffective for experts to process large amounts of textual data, categorize words and phrases, and create a useful E&S dictionary (Li et al. 2021). Accordingly, we use a machine learning alternative when measuring E&S disclosure in a large-scale textual dataset.

Researchers in accounting and finance increasingly rely on machine learning techniques in textual analysis to derive valuable information from corporate disclosures (see Guo, Shi, and Tu 2016 for a detailed review). Naïve Bayes, Support Vector Machine (SVM), and topic modeling with Latent Dirichlet Analysis (LDA) are among the most popular techniques applied in accounting and finance literature. In this study, we choose the machine learning technique called word embedding, a breakthrough in natural language processing (Mikolov et al. 2013). Using word embedding, Li et al. (2021) start with seed words that define "cultural values" and create a

[7] For example, an expert in federal health law knows that the acronym "HIPAA" stands for the Health Insurance Portability and Accountability Act of 1996 and could categorize the term under the *Social* dimension of E&S. Likewise, a chemist or materials scientist can assign the acronym "PFCs" to the *Environmental* dimension of E&S. ("PFCs" is an abbreviation for perfluorocarbons that contain fluorine and carbon atoms.)

"culture dictionary" from earnings call transcripts. Their study shows that the word embedding technique, as a semi-supervised machine learning approach, can indeed learn the context-specific meanings of words and phrases in large-scale datasets, and therefore holds promise for application in the social sciences.

Moreover, the word embedding technique provides additional advantages compared to other machine learning approaches in our setting. First, given the wide-ranging topics and continually developing techniques related to E&S, supervised machine learning approaches (e.g., SVM and Naïve Bayes) may be unreliable, as they require human experts to accurately label the desired E&S disclosure terms in the training sample. Second, E&S-related discussions might be limited compared to discussions about financial condition and performance in annual reports. Hence, it may be difficult for topic modeling techniques (e.g., LDA) to segregate E&S disclosures into independent topics. Third, the differences among the subtopics that fall beneath the various environmental and social categories can be subtle; thus, an unsupervised learning method (e.g., LDA) is likely to bundle different E&S subtopics together, thereby generating outputs that are difficult to interpret. As a result, we adopt a word embedding model similar to that used by Li et al. (2021) (i.e., *Word2Vec)* to develop a dictionary of corporate E&S disclosure.

2.3. GENERATING THE E&S DISCLOSURE DICTIONARY

Word embedding is a technique that converts individual words and phrases into a numerical representation of the word (a vector). The technique is based on a well-established theory in linguistics: words that occur in similar contexts have similar meanings (Harris 1954). By representing words using vectors, word embedding maps each word into a point in a high-dimensional space, where the point reflects the word's meaning and relationships with other words, allowing us to identify synonyms and related words from common neighboring words.

The specific word embedding model we use in this study is called *Word2Vec*.[8] Given a large enough corpus, we first ask *Word2Vec* to "learn" the meaning of a specific word via a neural network that "reads" through the textual documents. We then use the trained embedding model to develop an expanded, context-specific dictionary to measure E&S-related disclosures.

We start with a set of curated seed words representing each dimension of E&S disclosures and eventually expand them into a dictionary. Based on the existing classifications and descriptions of E&S topics provided by voluntary disclosure frameworks and ESG rating agencies, we identify a list of E&S-related seed words and assign them to various E&S topics. First, we combine the MSCI ESG rating framework (MSCI 2022b) and the Government Accountability Office (GAO) ESG categories (GAO 2020) to generate seven E&S disclosure topics.[9] After careful examination, we classify the environmental dimension into four subtopics: Climate Change, Natural Resources, Pollution & Waste, and Ecosystem. We also classify the social dimension into three subtopics: Employees, Products & Customers, and Other Stakeholders.[10]

We then review the disclosure requirements and metrics discussed in major voluntary reporting frameworks to generate our list of seed words. We choose voluntary disclosure frameworks because they are designed for companies worldwide and cover a comprehensive list of E&S topics (unlike mandatory disclosure regulations, which are often issue-focused and localized). The six voluntary ESG reporting frameworks we included (i.e., CDI, CDSB, GRI, IIRC, SASB, and TCFD) all specify the types of environment-related information required (or

[8] *Word2Vec* refers to the algorithm created by Mikolov et al. (2013) for generating word embeddings. There are other algorithms available. For example, GloVe (or Global Vectors for Word Representation) is another algorithm for obtaining vector representations for words (https://nlp.stanford.edu/projects/glove/).
[9] The MSCI ESG rating framework contains classified ESG categories for evaluation and is widely cited and used (e.g., ESG guidebook by PricewaterhouseCoopers, Nov 2020).
[10] We provide annual report E&S disclosure examples for all seven subtopics in Table OA.2. Our dictionary contains some general E&S words such as "environment" and "sustainability." We include these words and related sentences in calculating our overall E&S disclosure measures but exclude them from any subtopic analyses, given the difficulty of categorizing them into a specific subtopic.

recommended) for disclosure. Four of the frameworks (i.e., CDSB, GRI, IIRC, and SASB) also specify the types of social-related information to be included in E&S disclosure (See Online Appendix B Panel A). We inspect all words and phrases related to environmental and social topics contained in these frameworks to form our seed word list.[11] The seed word list and allocations are presented in Table 2. Using the trained embedding model, we then expand the seed words into an E&S keyword dictionary containing a broad set of E&S-related words and phrases.[12] Li et al. (2021) include a detailed online appendix for the implementation of the *Word2Vec* algorithm. We largely follow their implementation and describe our steps in Online Appendix A.

2.4. VALIDATING OUR E&S DISCLOSURE DICTIONARY

Our study is among the first to employ a machine learning methodology to measure corporate E&S disclosure. To ensure the accuracy of our E&S disclosure dictionary constructed by the *Word2Vec* algorithm, we conduct a validation test that examines the agreement between

[11] We exclude words or phrases from our seed word list for the following three reasons. 1) The words or phrases contained in the ESG voluntary reporting frameworks do not show up in annual reports, such as "100-year flood zones"; 2) In cases where multiple words or phrases represent the same or very similar meaning (e.g., "diversity and inclusion" and "inclusion and diversity," "GHG emission" and "carbon emission"), we keep one of them in our final seed word list; and 3) When using word embedding to expand the dictionary, words and phrases outside the scope of a focal subtopic may be selected. For example, we exclude "ecological impact" from the seed word list for the subtopic of Ecosystem; otherwise, words and phrases such as "environmental impact" and "environmental footprint" would be categorized under Ecosystem.

[12] We retain the top 500 words and phrases that are closest in distance to the seed words for each subtopic. This approach is consistent with the common practice of applying word embedding in the accounting and finance domain (e.g., Li et al. 2021; Huang, Pacelli, Shi, and Zou 2024). We further assess the sensitivity of our results to research design choices or human intervention in the process. We find that our approach provides outcomes similar to trimming words using a single cutoff level of similarity/distance. For example, the median similarity cutoff across our seven subtopics for the top 500 words is 0.5571. If we use 0.5571 as the cutoff similarity to select words into our dictionary, we still observe an average correlation of 0.96 between our original length measure and the new measure across all seven subtopics, implying that this alternative approach has little impact on our takeaway. Also, when we implement an alternative threshold by only keeping the top 300 words and phrases under each subtopic, the correlation between our original length measure and the alternative measure remains very high for all seven subtopics, with an average of 0.97.

the E&S disclosure selected by our machine learning algorithm and the E&S disclosure identified by 15 students who serve as human raters.[13] The validation task starts with a training session that familiarizes each student with the same set of E&S seed words given to the machine and the idea of expanding seed words to synonyms. After completing the training session, students are asked to categorize 420 sentences that have already been classified by machine. Half of the 420 sentences are E&S-related and are composed of 30 randomly selected machine-identified sentences from each of the seven subtopics. We ask each rater to 1) independently identify whether a sentence is E&S-related, and, if so, 2) classify such sentences into at least one of the seven subtopics.

We provide additional details of the validation task and tabulate the results in Online Appendix C. Specifically, we find in Panel B of Online Appendix C that, on average, our methodology and a human rater agree on whether a sentence is E&S-related 94.98% of the time. Further, the average kappa statistic of 0.90 indicates excellent machine-human agreement. We also observe a reasonably good average machine-human agreement rate and kappa statistic for each of the seven subtopics in Panel C of Online Appendix C. Overall, the significant overlap between human-identified E&S disclosure (topics) and machine-selected E&S disclosure (topics) based on the word embedding technique suggests that our methodology identifies E&S disclosures and the underlying topics with relatively high accuracy, and enhances our confidence in applying this methodology in our empirical analyses.

[13] In addition to human validation, some of the empirical results in Section 4 provide further support for the validity of our measure. For example, in Section 4.2, we find that several factors of E&S disclosure quantity (e.g., firm size; standalone ESG report; ESG rating coverage) are significantly associated with our key E&S disclosure measures. Moreover, findings of the increase in E&S disclosure length surrounding the adoption of voluntary framework and most comprehensive E&S disclosure mandate in Sections 4.3 and 4.4 also help to enhance the credibility of our key measure. Using the same machine learning technique (i.e., *Word2Vec*), Li et al. (2021) measure corporate culture and use corporate activities and performance to validate their measures. In contrast to their setting, E&S disclosure in annual reports does not necessarily lead to ESG action in firms' operation, so a similar validation analysis doesn't fit our setting. As a result, we do not directly link our measures to corporate ESG performance.

3. Data and Variables

3.1. DATA

We obtain international firms' annual reports from *Refinitiv Global Filings* (RGF). RGF provides comprehensive coverage of regulatory filings, such as annual and quarterly reports, for over 138 countries around the world. Our study covers 30 countries around the world during the period from 2001 to 2020; all countries have at least 30 firms per year in RGF issuing annual reports written in English, along with the requisite financial data. All annual reports from RGF are in PDF format.[14] To parse the relevant information from the annual reports, we first extract text from the PDF files. Our Online Appendix A provides additional details on our procedures for parsing the annual reports.

An annual report is a comprehensive business document that provides stakeholders with a holistic view of a firm's financial position and operations performance over the past fiscal year. Some key elements commonly seen in annual reports include the letter to shareholders, business summary and review, management discussion and analysis, and reports on corporate governance and the board of directors.[15] Unlike annual reports that concentrate mostly on corporate financial positions and operational outcomes (including material E&S activities and key metrics), stand-alone ESG reports only focus on firms' environmental and socially

[14] We do not include US firms in our sample because the RGF database only provides form 10-K for these firms, which is a formal regulatory filing with the SEC. Form 10-Ks are prepared under strict formatting requirements following SEC rules and tend to be plain-looking; in contrast, annual reports are intended for shareholders and other stakeholders, and typically include many charts, graphs, and illustrations. We require such infographic information to estimate one of our E&S disclosure attributes: *Visual*.

[15] We further analyze the distribution of E&S information in annual reports. This analysis sheds light on whether firms provide E&S information in the "fluff" part of annual reports or as a part of financial statements and related notes. In Figure OA.1, we plot the distribution of E&S information and financial statements separately for each year using heatmaps. In the heatmap of E&S information, we observe darker shades mostly at the front end of the annual reports, indicating that E&S information usually shows up where firms provide glossy discussions of their business. In contrast, the heatmap of financial statements suggests that such information is typically located in the middle or near the end of the annual reports. Overall, the location of E&S information does not seem to overlap much with that of financial statements.

responsible activities. Given the distinct disclosure scope of the two types of reports, we also examine later in the paper whether firms that issue stand-alone ESG reports provide less E&S information in annual reports.

Panel A of Table 1 describes the sample construction process. Our descriptive analysis sample includes 217,422 annual reports from 24,271 unique firms. The sample size of our regression analysis ranges from 111,231 to 183,271, depending on the dependent variable and specification. Panel B of Table 1 lists the countries included in our sample. We also provide the number of observations from every country in each of the subperiods: 2001-2005, 2006-2010, 2011-2015, and 2016-2020. [16]

3.2. VARIABLES

To provide a complete picture of the changing landscape of corporate E&S disclosure, we examine five textual attributes of E&S disclosure in annual reports: 1) the volume of qualitative disclosure (*Length*); 2) the occurrences of generic and standardized language in E&S disclosure (*Boilerplate*); 3) the specificity of E&S disclosure (*Specificity*); 4) disclosure stickiness over time for the same firm (*Stickiness*); and 5) visual cues that accompany E&S disclosure in annual reports (*Visual*). In this section, we provide detailed explanations of how we empirically measure each attribute.

[16] We use the entire annual report sample to train the word embedding models. Word embedding models capture the meanings of words using their co-occurrence relationships in documents. For example, both *greenhouse* and *emissions* tend to frequently appear near a similar set of words, such as *gas*, *warming*, and *carbon*, so they are close to each other in vector space in our trained model. Thus, even if our sample is more weighted toward the later periods, as long as the meanings of the words do not change over the years, *greenhouse* and *emissions* will continue to appear around similar neighboring words, and the embedding model should still be able to capture the meanings of the words. As a result, the selection of words is based on their global similarity to the seed words, regardless of the periods in which they tend to appear. We also provide robustness checks by using words only appearing in the first half of our sample period to avoid the concern that the word selection process tends to bias toward later periods as a result of the growing popularity of E&S disclosure in annual reports. In Table OA.3 of the Online Appendix, our main results remain similar when using this alternative E&S dictionary.

3.2.1.E&S disclosure length

We first study the quantity of E&S disclosure (*Length*) in annual reports. Examining the length of disclosure answers the fundamental question of whether the amount of E&S information available in annual reports has changed over time, as prior studies often argue that a greater quantity of disclosure should in general be more informative, all else being equal (e.g., Lang and Stice-Lawrence 2015). We measure the *Length* of E&S disclosure using the total number of words within E&S-related disclosures in an annual report.[17] E&S-related disclosures are defined as sentences containing words and phrases that appear in our E&S keyword dictionary. We also measure the disclosure quantity for each E&S subtopic. $Length_i$ is calculated as the total number of words in E&S-related disclosures for E&S subtopic *i*.

3.2.2.Boilerplate in E&S disclosure

To evaluate the general trend in E&S disclosure quality, we further examine several disclosure attributes that likely affect the informativeness of E&S disclosure. First, to address the concern that firms only provide generic E&S disclosure that offers insufficient context for accompanying quantitative disclosures and are not specific to how firms address E&S issues (e.g., GAO 2020), we empirically measure the extent to which firms use boilerplates language in their E&S disclosures. We follow the approach of Lang and Stice-Lawrence (2015) to identify E&S boilerplates and calculate *Boilerplate* using the number of E&S sentences containing boilerplate phrases divided by the total number of E&S sentences.[18]

[17] We believe that the raw word count of E&S-related sentences provides a less noisy measure that more accurately reflects the changes in the E&S disclosure landscape. Therefore, we choose not to scale it by the total word count of the annual report because the length of annual reports has also significantly increased during our sample period and may confound our construct of interest (Lang and Stice-Lawrence 2015).

[18] The approach is based on the idea that boilerplate text contains extremely common phrases. First, we identify four-word phrases (tetragrams) that occur in more than 30% of the documents in a country and at least five times per document on average. Second, these tetragrams are further narrowed down to those that appear in more than 60% of the documents in the firm's home country. Third, we exclude tetragrams appearing in more than 80% of the documents and those appearing in more than 75% of the entire corpus

3.2.3. Specificity of E&S disclosure

Second, we study the specificity of E&S disclosure in annual reports (*Specificity*). Hope et al. (2016) find that more specific disclosures are more precise and informative. Following prior literature (e.g., Hope et al. 2016; Dyer, Lang, and Stice-Lawrence 2017), we calculate *Specificity* as the number of specific words conveying specific names, quantitative values, and times and dates in E&S-related disclosures, scaled by the total number of words in E&S-related disclosures.[19] A higher value of *Specificity* suggests that a firm provides more specific E&S information in its annual report.

3.2.4. Disclosure stickiness

A recent SASB survey suggests that many public firms make very few modifications to ESG disclosures year-over-year in their regulatory filings in the US (SASB 2017), raising concerns about the usefulness of ESG disclosure in annual reports. We explore this phenomenon in the global setting by examining the stickiness of E&S disclosure over time for the same firm (Brown and Tucker 2011). To assess E&S disclosure stickiness, we construct a time-series similarity variable (*Stickiness*) as the cosine similarity between E&S-related disclosures in year *t*'s annual report and those in year *t-1*'s annual report for the same firm.[20] Consistent with prior research,

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across all countries. Boilerplate sentences are the ones that contain at least one of the previously identified boilerplate tetragrams. To verify that our results are not sensitive to the construction of the boilerplate measure, we perform robustness tests using an alternative measure following Cazier, McMullin, and Treu (2021). We identify boilerplate language using the following steps: (1) Identify commonly used trigrams as those that appear between 10% and 90% of all the firms in the same two-digit SIC industry; (2) Identify standardized sentences as those that either use ten or more of these trigrams or for which 10 percent or more of the trigrams in the sentences are commonly used; (3) Estimate boilerplate as the ratio between the number of words in the standardized sentences divided by the total number of words in the document. Our inferences remain the same.

[19] Note that our disclosure specificity measure only reflects the specificity of E&S disclosure in the text but does not include tables or figures, largely due to the difficulty of extracting textual content from figures.

[20] We exclude the bottom 10% of observations in terms of file sizes and annual reports with fewer than 100 words from E&S sentences when calculating the stickiness measure to avoid potential bias and noise introduced by these observations.

our stickiness measure captures the extent to which a firm re-uses its own E&S disclosures from prior periods (Dyer et al. 2017). A higher value of *Stickiness* indicates fewer year-over-year modifications to a firm's E&S disclosures.[21]

3.2.5. Disclosure visual cues

Firms sometimes provide infographics to complement E&S-related narratives. Moreover, recent studies have shown that visual cues better attract investors' attention and help readers to interpret the relevant disclosures (Nekrasov, Teoh, and Wu 2021; Christensen et al. 2024). To assess the amount of E&S disclosure-related infographics in annual reports, we measure visual cues (*Visual*) as the total number of tables and figures used in E&S-related disclosures.[22] Specifically, we identify E&S-related tables as those that include E&S keywords from our dictionary, and we classify a figure as E&S-related if it appears within 300 words before or after an E&S-related sentence.[23] We provide details on how we identify tables and figures accompanying E&S-related text in Online Appendix A.

4. The Evolution of E&S Disclosure

In this section, we first explore various country- and firm-level factors that explain the variation in E&S disclosure attributes. This analysis also develops a baseline model for examining our main research questions. Next, we present both descriptive evidence and regression analyses

[21] We acknowledge that a higher value of stickiness does not necessarily imply low disclosure quality. For example, some firms may follow the same disclosure format but update the quantitative metrics provided in the disclosure every year, which will lead to stickier but more comparable disclosure.

[22] Unlike existing literature examining visual cues in 10-K reports or on Twitter (e.g., Nekrasov et al. 2021; Christensen et al. 2024), our study faces at least three challenges in measuring visual cues. First, we provide a continuous variable instead of an indicator variable of infographics. Second, compared with a 10-K form in XML format and a Twitter post in HTML format, global annual reports are all in PDF format, making the task of extracting tables and figures much more difficult. Last, instead of simply counting all infographics contained within an entire document, we need to identify the infographics related to E&S topics only.

[23] We use 300 words as the cutoff because, in our annual report sample, one page contains an average of approximately 300 words. Hence, our measure likely captures figures presented on the same page as E&S-related text.

of the evolution of E&S disclosure over the past two decades. Finally, we explore how voluntary reporting frameworks and mandatory regulations have shaped E&S disclosure attributes.

4.1. E&S DISCLOSURE LANDSCAPE: COUNTRY- AND FIRM-LEVEL FACTORS

In this section, we aim to enhance our understanding of how different factors have contributed to E&S disclosure practices. Drawing on prior literature on ESG disclosure (Baldini et al. 2018), we explore three categories of country-level characteristics: environmental factors, social factors, and market forces.

Under the environmental dimension, we examine four factors: the percentage of forest in a country's total land area (*Forest pct*), the total rent of natural resources as a percentage of GDP (*Natural resource rent*), the percentage of renewable energy relative to total energy consumption (*Renewable energy*), and greenhouse gas emissions per capita (*GHG per capita*). Along the social dimension, we consider the female labor participation rate (*Female labor pct*), expected lifespan at birth (*Life expectancy*), total population of the country (*Population*), legal environment (*Rule of law*), and unemployment rate (*Unemployment*). These variables are indicative of various aspects of a society's stage of development. Lastly, we consider factors reflecting countries' institutional environment and market forces, including the value of agriculture, forestry, and fishing added as a percentage of total GDP (*Agriculture pct*), annual GDP growth rate (*GDP growth*), GDP per capita (*GDP per capita*), capital market size relative to GDP (*Market Cap / GDP*), and the level of earnings management in a country (*Opaqueness*). We obtain all these country-level variables from the World Bank, except *Opaqueness*, which is estimated using Worldscope data following Leuz et al. (2003).

In addition to examining country-level factors, we also draw inspiration from existing literature on ESG disclosure and firm characteristics. For example, prior studies find that several firm characteristics, such as size and Tobin's Q, are associated with firms' decisions to provide

voluntary ESG disclosure (e.g., Dhaliwal et al. 2011). There is also extensive evidence that firms provide ESG disclosure to satisfy information demand from stakeholders such as investors, analysts and rating agencies (e.g., Chan et al. 2014; Baldini et al. 2018; Arif and Golshan 2023; Robinson et al., 2023). Finally, it is an empirical question whether or not stand-alone ESG reports could substitute for E&S disclosures in annual reports. Therefore, we control for the issuance of stand-alone ESG reports to better understand the interaction between different disclosure channels.

We estimate the following regression to examine the association between all of the above-mentioned factors and corporate E&S disclosure in annual reports.

$$ES\ disclosure = \beta_0 + \beta_1 Environmental\ Factors + \beta_2 Social\ Factors + \beta_3 Market\ Forces + \beta_4 Firm\ Chars + \varepsilon \quad (1)$$

In addition to the above-mentioned controls, we also include *Total words* in all regressions and *Total boilerplate*, *Total specificity*, *Total stickiness*, or *Total visual* in each corresponding disclosure quality regression to control for the overall disclosure attributes of the annual report. We list the definition and sources of our five *ES Disclosure* variables and all the *Environmental Factors*, *Social Factors*, *Market Forces*, and *Firm Chars* in the Appendix. Descriptive statistics for all variables are reported in Table 3.

We present results from estimating equation (1) in Table 4. In Panel A of Table 4, we focus on the quantity of E&S disclosure in annual reports (*Length*) and include country-level factors and firm characteristics in separate specifications.[24] Overall, country-level factors have relatively limited explanatory power. The adjusted R^2 is 13.3% in column (1) when we include

[24] Note that the number of observations varies across columns due to observations dropping out with various fixed effects and different data requirements. In Table OA.4, we repeat the analysis in Table 4 Panel A by including environmental factors, social factors, and market forces separately without any fixed effects. Similarly, in Table OA.5, we perform the analysis in Table 4 Panel B by removing all fixed effects.

environmental factors, social factors, and market forces in the model. In contrast, firm characteristics explain 49.1% of the variation in E&S disclosure quantity, as suggested by the adjusted R^2 in column (2). The adjusted R^2 further increases from 57% in column (4) to 77.2% in column (5) when we replace country fixed effects with firm fixed effects. Overall, the results suggest that E&S disclosure is largely shaped by firm characteristics rather than country-level factors.

However, some country-level factors are consistently associated with E&S disclosure quantity across several specifications. For example, among environmental factors, firms in countries that use more renewable energy (*Renewable energy*) and have greater levels of greenhouse gas emissions (*GHG per capita*) discuss more E&S issues in their annual reports. This result may be driven by social awareness of environmental issues.

With respect to social factors, we find that firms in countries with longer life expectancy provide more E&S information. One possible explanation for this result is that stakeholders who expect to live longer care more about sustainability and thus demand more E&S information so they can plan for their future. In addition, longer life expectancy is likely associated with an aging society, which is a growing issue in many developed countries. This type of society typically has greater demand for social disclosure (de la Croix and Licandro 1999). Similarly, the unemployment rate in a country, often a proxy for societal problems, is also positively associated with the length of E&S disclosure in column (1). Consistent with prior research (Baldini et al. 2018), there is also some evidence that firms located in countries with stronger legal environments (*Rule of law*) provide less E&S disclosure in their annual reports, likely because there is less demand for E&S information in countries with more formal rules and constraints.

As for market forces, the results in columns (1) and (3) suggest that firms in countries with slower GDP growth (*GDP growth*) and more developed capital markets (*Market Cap/GDP*)

disclose more E&S information, consistent with the conjecture that firms in developed economies place greater weight on sustainable growth. However, the coefficients on some of these variables lose significance or flip when we include firm characteristics and fixed effects. In addition, there is some evidence that firms in countries with more earnings management (*Opaqueness*) provide less E&S disclosure, suggesting that firms' financial reporting incentives seem to align with their E&S reporting incentives in an investor-oriented disclosure channel (i.e., annual reports).

Among firm characteristics, common voluntary disclosure determinants are also associated with E&S disclosure quantity. For example, firms that are larger in size and with more analyst coverage and institutional holdings provide more E&S disclosure, consistent with the argument that E&S information demand from stakeholders motivates firms' disclosure decisions. Moreover, firms that receive third-party ESG ratings provide significantly more E&S discussion, indicating that coverage by external ESG rating agencies seem to be positively associated with firms' disclosure practices. Interestingly, firms issuing separate ESG reports also provide more E&S discussion in their annual reports, suggesting that firms with more relevant E&S-related activities discuss them in both disclosure channels, and separate ESG reports do not substitute for E&S disclosures in annual reports.

In Panel B of Table 4, we examine how environmental factors, social factors, market forces, and firm characteristics are associated with other aspects of E&S disclosure including *Boilerplate, Specificity*, *Stickiness*, and *Visual*. We include all the above-mentioned country- and firm-level factors. We first control for country and year fixed effects and then replace country fixed effects with firm fixed effects. Among environmental factors, we find that firms in countries with higher greenhouse gas emissions (*GHG per capita*) provide less specific and stickier E&S disclosure but incorporate more infographics. As for social factors, firms in countries with greater female labor participation (*Female labor pct*) seem to consistently disclose higher quality social information, as

evidenced by lower boilerplate, higher specificity, and more infographics. We do not observe many significant coefficients on variables related to market forces. Finally, largely consistent with the results in Panel A, there is some evidence that firms with more information demand (e.g., higher analyst coverage; ESG ratings coverage) and firms issuing standalone ESG reports provide more visual information, use less boilerplate language, and include more specific information in their E&S disclosures.

4.2. E&S DISCLOSURE TRENDS FROM 2001 TO 2020

4.2.1. Evolution of E&S disclosure attributes

In this section, we explore the evolution of E&S disclosure over the past two decades using both descriptive and regression analyses. We start by providing descriptive evidence on the time trends in E&S disclosure quantity and quality in Figure 1. In Panel A of Figure 1, we plot the mean, the median, the 25th percentile, and the 75th percentile of the amount of E&S disclosure in annual reports (*Length*) for each year from 2001 to 2020. Overall, consistent with our intuition and anecdotal evidence, there has been a strong upward trend in the average amount of E&S disclosure in annual reports over the past two decades. Specifically, the length of E&S disclosure has sharply increased over the past 15 years, especially since 2015. By the end of our sample period, the median word count for E&S-related sentences in annual reports is over 1700, more than six times of what it was in 2001. In addition, we find in untabulated analysis that the fraction of firms with zero E&S disclosure has drastically decreased, from 8.6% in 2001 to 1.1% in 2020.

Similarly, we investigate the time trends associated with other E&S disclosure measures that likely reflect disclosure quality. Specifically, we plot the median, the mean, the 25th percentile, and the 75th percentile of *Boilerplate*, *Specificity*, *Stickiness*, and *Visual* every year from 2001 to 2020 in Panels B to E of Figure 1. Several interesting patterns emerge. Consistent with practitioners' concerns (e.g., SASB 2017; GAO 2020), the median proportion of boilerplate language in E&S

disclosure increased from 3.6% to over 12.5% during the first 15 years of our sample period. However, the trend has reversed in the last five years, likely due to stakeholders' growing concern and efforts to address this issue. The median percentage of specific words and phrases in E&S sentences has slightly dropped from about 5.5% to a little over 5% in 20 years, suggesting that E&S disclosure has become less specific during the past two decades. [25] Further, although E&S disclosure was already very sticky at the beginning of our sample, consistent with the high explanatory power of firm fixed effects documented in Section 4.1, the stickiness of E&S disclosure has further increased in recent years, suggesting that firms are increasingly reusing their disclosures from prior years. This result may not necessarily signal deteriorated disclosure quality because the adoption of ESG voluntary frameworks and issuance of E&S disclosure mandates could also lead to more consistent disclosure of material E&S activities and metrics. At the same time, firms are incorporating more and more infographics (i.e., figures and tables) into their E&S disclosures. The median number of E&S-related figures and tables has increased from around three at the beginning of our sample period to eight by 2020. Overall, Panels B to E of Figure 1 show marked trends in the overall quality of E&S disclosure in annual reports over time and complement the change in the quantity of E&S disclosure documented in Panel A. In Figures OA.2 and OA.3, we plot the time trends in E&S disclosure attributes by geographic region (i.e., Asia; Europe; Others) and by Fama-French 5-industry. The trends by region and by industry are similar to what we observe in the full sample, although the changes in specificity and stickiness over time appear to be more volatile when plotting by regions.

[25] In untabulated analysis, we find that the absolute number of specific words and phrases provided in E&S sentences has significantly increased over time. However, the change is not as drastic as the increase in total E&S disclosure, resulting in the downward trend in the proportion of specific E&S disclosure documented in Panel C of Figure 1.

We also formally test the time trend of each E&S disclosure attribute by estimating the following regression model. We include the same set of country- and firm-level factors as in equation (1), firm fixed effects, and a variable for time trend (*Trend*).

$$ES\ disclosure = \beta_0 + \beta_1 Trend + \beta_2 Environmental\ Factors + \beta_3 Social\ Factors + \beta_4 Market\ Forces + \beta_5 Firm\ Chars + \varepsilon \quad (2)$$

ES Disclosure is *Length*, *Boilerplate*, *Specificity*, *Stickiness*, or *Visual* depending on the specification. *Trend* is the year of the annual report minus 2000. We report the results on the trend of E&S disclosure in Panel A of Table 5. Overall, most of our regression results are consistent with the findings in Figure 1. We observe a significant coefficient on *Trend* for three of the five E&S disclosure attributes. Specifically, the *Length* of E&S disclosure has expanded over time as suggested by column (1). However, E&S disclosure has also become more generic (*Boilerplate*) and less specific (*Specificity*), as shown in columns (2) and (3). Although Figure 1 shows some upward trends in E&S disclosure stickiness and infographics, the coefficient on *Trend* is statistically insignificant in columns (4) and (5) when we use the corresponding dependent variable. In Panel A of Table OA.6, we perform an additional analysis to explore whether the observed trends are attributable to sample composition changes. Specifically, we only include firms that have appeared in our sample at least 10 times and re-estimate the trend regressions. We continue to observe similar changes in E&S disclosure quantity and quality over time, suggesting that our trend results are at least not completely driven by new firms entering the sample.

Since E&S disclosure to some extent reflects the underlying activities of the business, it is possible that E&S disclosure has exhibited different trends across industries. To empirically test this conjecture, we estimate a modified version of equation (2) by interacting *Trend* with indicators for Fama-French 5 industries and present the results in Panel B of Table 5. Although

the general trend in E&S disclosure appears largely similar across these five industries, we do observe some slight differences in terms of magnitude. For example, the manufacturing industry exhibits the greatest increase in E&S disclosure length, and the greatest decrease in disclosure specificity. In untabulated analyses, we further find that the coefficient magnitudes for the manufacturing industry are statistically larger than those for the consumer industry and "other industries". In addition, the high-tech industry shows the largest increase in boilerplate language, and only firms classified as "other industries" exhibit significant increases in disclosure stickiness over time.

4.2.2. Evolution of E&S disclosure subtopic and vocabulary

To shed light on the changing landscape of E&S disclosure and which subtopics are driving the pattern of drastically increasing overall E&S disclosure documented in Figure 1 Panel A, we further provide the annual average of disclosure quantity for each E&S subtopic ($Length_i$) from 2001 to 2020 in Panel A of Figure 2. Among our four environmental subtopics, two have remained largely stable (Ecosystem and Pollution & Waste) and one has slightly declined over time (Natural Resources), while the amount of climate change discussion has significantly increased in the last 5 years. With respect to social disclosure, discussions of all three subtopics have significantly expanded over the last 20 years, especially Human Capital and Other Stakeholders. This evidence suggests that disclosures associated with certain E&S topics have grown more rapidly than others during our sample period, likely due to stronger demand for this type of information from stakeholders.

To better understand the changing landscape of the relative importance of E&S subtopics, we plot how the importance of each E&S subtopic relative to the total amount of E&S disclosure has evolved over time. For each firm, we calculate the number of words for sentences within an E&S subtopic scaled by the total number of words in E&S-related sentences within its annual

report, then calculate the average for all the firms within each year in our sample period. We repeat the process for all seven subtopics. Panel B of Figure 2 provides evidence that the relative weight of E&S topics has evolved over the past two decades. Overall, the proportion of social disclosure has slightly increased over the past decade and has exceeded environmental disclosure. In terms of environmental disclosure, although Natural Resources remains the most frequently discussed topic, its relative importance has gradually declined over time. Climate Change disclosure has gained more importance over the past five years, consistent with greater social awareness of this issue. As for social disclosure, Human Capital has quickly expanded in recent years and approached a similar level of relative importance as Products & Customers.

In addition to the shift in relative importance of E&S subtopics, we attempt to understand which detailed E&S issues have become more prominent in corporate E&S disclosure over time by exploring the time-series variation in the most commonly used E&S vocabulary. In Panel A of Figure 3, we first present the top 20 most frequently used words and phrases in E&S disclosure for each of the following five-year subperiods: 2001-2005, 2006-2010, 2011-2015, and 2016-2020. We color code each cell to indicate which subtopic the word or phrase belongs to. We note several interesting findings. First, several environmental-related words and phrases remain the most frequently used E&S vocabulary throughout our sample period (e.g., gas; oil; water), while climate change related words and phrases (e.g., emission) have gained a significant position over time. Second, it appears that social disclosure has shifted from product and customer issues (e.g., technological; product development) to broader stakeholder-oriented social issues (e.g., ethical; workforce).

In Panel B of Figure 3, we list the top 20 E&S words and phrases with the largest increase in frequency. We calculate and compare the difference between the frequency of a word or phrase in 2001-2005 vs. 2016-2020. Consistent with our earlier findings, phrases such as "greenhouse gas"

and "carbon" have climbed up the ranking in recent years as firms and stakeholders become more aware of climate change-related issues. As for social disclosure, words and phrases related to other stakeholders (e.g., violation; misconduct) and workforce diversity (e.g., discrimination; workplace) have become more frequently mentioned toward the end of our sample period. Similarly, we report the top 20 E&S words and phrases with the largest decrease in frequency in Panel C of Figure 3. Words and phrases under the Products & Customers subtopic (e.g., product range; product quality; customer service) occupy most of this list, confirming our previous finding that E&S disclosure has shifted away from product- and customer-related issues. Overall, Figure 3 provides nuanced evidence of how the business world's focus on specific E&S issues has evolved over time.

4.2.3. Evolution of E&S disclosure rankings by country

Finally, to better understand in which countries E&S disclosure has matured and in which countries E&S disclosure practices are still emerging, we plot each country's E&S disclosure *Length* ranking and visualize ranking changes over our sample period. Specifically, we calculate the average E&S disclosure *Length* for each country in 2001-2005 and 2016-2020 and then create rankings for 2001-2005 and 2016-2020 separately. Figure 4 illustrates total E&S disclosure quantity ranking by country for the two subperiods. Overall, the top quartile mostly comprises developed countries in Europe, while developing economies in Asia are concentrated within the bottom quartile. However, several countries in Asia (e.g., Indonesia, Hong Kong, China, Japan) have improved the most in our ranking. In contrast, some European countries (e.g., Denmark, Sweden, Russia) have gone in the opposite direction in the same ranking. In untabulated analyses, we further examine how the absolute amount of E&S disclosure has changed for each region (i.e., Asia, Europe, and other) over time. We find that the average E&S disclosure quantity has grown

by over 300% during our sample period in both Asian and European countries, although the relative rankings have moved in different directions for these two regions.

4.3. VOLUNTARY FRAMEWORKS AND DISCLOSURE ATTRIBUTES

During the last two decades, dozens of ESG reporting standards and frameworks have emerged, most of which are developed and managed by independent international organizations. The most well-known voluntary disclosure frameworks include CDP, CDSB, GRI, IIRC, SASB, and TCFD (Eccles and Mirchandani 2022). Panel A of Online Appendix B outlines these ESG disclosure frameworks and describes key characteristics of each framework. Given the rise of voluntary ESG reporting frameworks during our sample period, we explore whether these voluntary frameworks have also contributed to the changing landscape of E&S disclosure.

By searching for the full names or the abbreviations of the six organizations and their corresponding frameworks in our sample annual reports, we create an indicator variable for the adoption of a voluntary ESG reporting framework (*Framework*). *Framework* equals one if the names of these organizations or frameworks appear in the annual report at least once. The underlying assumption is that a firm has likely adopted the ESG reporting framework if it mentions the name of the corresponding organization or the framework in its annual report. Similarly, we create six separate indicator variables for each framework to help us understand the differential trends or effects of these voluntary ESG reporting frameworks.

In Figure 5, we first provide descriptive evidence on the percentages of firms that have adopted the six voluntary ESG reporting frameworks every year during our sample. Overall, we observe a strong upward shift in the percentage of firms that have adopted voluntary reporting frameworks. As of 2020, nearly 20% of firms in our sample have adopted at least one voluntary

reporting framework. Among the six frameworks, GRI appears to be the most popular, while there has also been a sharp increase in the number of firms adopting TCFD since 2017.[26]

Next, we estimate the following regression to formally examine the association between adopting voluntary ESG reporting frameworks and corporate E&S disclosure attributes in annual reports.

$$ES\ disclosure = \beta_0 + \beta_1 Framework + \beta_2 Environmental\ Factors + \beta_3 Social\ Factors + \beta_4 Market\ Forces + \beta_5 Firm\ Chars + \varepsilon \quad (3)$$

ES Disclosure represents *Length*, *Boilerplate*, *Specificity*, *Stickiness*, and *Visual* in different specifications. *Framework* is a dummy variable that takes the value of one if a firm has mentioned the name of at least one voluntary ESG reporting framework in its annual report, and zero otherwise. We also replace *Framework* with six separate indicators (i.e., *CDP*, *CDSB*, *GRI*, *IIRC*, *SASB*, and *TCFD*) for each organization in alternative specifications. We include the same set of control variables as equation (1). We also control for firm and year fixed effects.

We present the results with *Framework* as the key independent variable in Panel A of Table 6. Overall, we find that the adoption of a voluntary ESG reporting framework is associated with a greater amount of E&S disclosure, representing a 32% increase relative to the sample mean. In terms of E&S disclosure attributes, the adoption of a voluntary ESG reporting framework is associated with less generic E&S disclosure, as indicated by less boilerplate language, and more infographics. At the same time, firms that rely on voluntary ESG reporting frameworks also seem to provide more similar and consistent E&S disclosures year-over-year, as evidenced by higher disclosure stickiness. Similar to the trend analysis, we also examine whether the observed associations are a result of new firms entering the sample or existing firms adopting voluntary

[26] The percentage of firms using SASB standards is relatively low, probably because SASB is a U.S. organization, and our sample is composed of international firms.

frameworks. In Panel B of Table OA.6, we re-estimate equation (3), but only include firms with at least 10 observations during our sample period. We continue to observe similar changes in *Length*, *Boilerplate*, *Stickiness*, and *Visual* using this smaller sample, suggesting that our main results in Table 6 Panel A are, at a minimum, not entirely due to sample composition changes.

When we separately examine these six voluntary frameworks in Panel B of Table 6, we observe a similar association between E&S disclosure quantity and certain attributes (e.g., *Length*; *Visual*) across frameworks. However, the decrease in boilerplate language and the increase in disclosure stickiness are concentrated among firms using GRI, although the coefficients for *GRI* are not always statistically different from those of other frameworks. Firms adopting CDSB show a statistically larger increase in boilerplate language than do firms using other frameworks. Interestingly, the adoption of IIRC and SASB is associated with more specific E&S disclosure, but the adoption of other frameworks is not associated with changes in disclosure specificity.

Overall, the results shown in Table 6 suggest that the proliferation of the usage of voluntary ESG reporting frameworks appears to be associated with improvements in E&S reporting practices around the world. However, the causal relationship between ESG reporting frameworks and E&S reporting practices is unclear. On the one hand, the proliferation of standardized frameworks could be driving firms' E&S disclosure practices. On the other hand, firms that disclose more E&S information to satisfy investors' requests are more likely to adopt ESG reporting frameworks, and these frameworks may help to harmonize and coordinate E&S disclosure practices.

4.4. E&S DISCLOSURE MANDATES AND DISCLOSURE ATTRIBUTES

Amidst growing concern that voluntary reporting regimes lack unified standards and monitoring, a push for standardized mandatory E&S reporting has begun to gain momentum, and many jurisdictions have either adopted E&S disclosure regulations or are in the process of

doing so. We provide a comprehensive summary of E&S disclosure mandates across our sample countries during the period from 2001 to 2020. Panel B of Online Appendix B lists the names, issuance dates and effective dates of the first and the most comprehensive mandatory E&S disclosure regulations. Overall, we find that 23 of the 30 countries in our sample have mandated some form of E&S disclosure by the end of 2020. Nineteen of these 23 countries issued multiple E&S mandatory disclosure regulations during our sample period.

Ex ante, it is not clear whether E&S disclosure attributes change significantly after certain E&S disclosure mandates. First, all existing financial reporting standards (e.g., IFRS) require firms to disclose business activities that have material impacts on firms' financial conditions and risks. Therefore, relevant and material E&S information may have already been disclosed in annual reports before the country issues any new E&S disclosure mandate. Second, it is not clear how E&S disclosure quality changes in relation to E&S disclosure mandates. On the one hand, mandatory E&S reporting regulations can positively impact corporate E&S disclosure quality. For example, Grewal, Richardson, and Wang (2023) find that unrepresentative disclosure (i.e., sharing information with less harmful environmental impacts and hiding information with more environmental damages) decreases after mandatory carbon reporting became effective in the UK. On the other hand, mandatory E&S reporting may not significantly enhance E&S disclosure quality. E&S disclosure covers a wide array of topics that are often forward-looking, non-monetary, and intangible in nature, so even a unified set of standards may still leave sufficient room for firms to make discretionary disclosure choices. In fact, firms may provide boilerplate disclosures simply to comply with the standards. Consistent with this notion, prior research in the international accounting literature suggests that firms' disclosure practices are largely determined by managers' reporting incentives rather than by standards alone (e.g., Ball, Robin, and Wu 2003; Leuz et al. 2003; Burgstahler, Hail, and Leuz 2006; Daske et al. 2013). As a result,

mandatory E&S reporting may have a limited effect on many disclosure attributes, especially in countries with weak monitoring and enforcement. In this section, we empirically study whether corporate E&S disclosure attributes have significantly changed with the adoption of E&S disclosure mandates.

We examine both the first and the most comprehensive E&S disclosure mandates for each country during our sample period. We estimate the following regression with firm and year fixed effects to test the relationship between E&S disclosure mandates and E&S disclosure attributes in annual reports using a staggered difference-in-differences design.[27]

$$ES\ disclosure = \beta_0 + \beta_1 Mandate + \beta_2 Environmental\ Factors + \beta_3 Social\ Factors + \beta_4 Market\ Forces + \beta_5 Firm\ Chars + \varepsilon \quad (4)$$

ES Disclosure is measured by *Length*, *Boilerplate*, *Specificity*, *Stickiness*, and *Visual*, respectively. *Mandate* is either *Mandate First* or *Mandate Comp*. *Mandate First* is an indicator that equals one if the first E&S disclosure mandate during our sample period for the country has become effective, and zero otherwise. *Mandate Comp* is a dummy variable that takes the value of one if the most comprehensive E&S disclosure mandate during our sample period for the country has become effective, and zero otherwise. We include the same set of control variables given in equation (1).

We present our results on the first E&S disclosure mandate in each country in Panel A of Table 7. Overall, we do not observe any significant changes in E&S disclosure attributes following a country's first E&S disclosure mandate. This finding may be driven by the fact that the initial E&S mandates often require disclosure of environmental and social risks/opportunities that have a material impact on firms' financial position, and such disclosure may already have been

[27] Since we control for year fixed effects in this model, we no longer include the *Trend* variable.

provided prior to the mandate due to materiality. For example, the Modernization Directive of June 18, 2003 (2003/51/EC) requires that EU companies examine and report on key financial and non-financial indicators that materially affect the development or performance of the firm in their annual report.[28]

We next investigate changes in E&S disclosure attributes around the adoption of the most comprehensive E&S disclosure mandate in each country. We manually search for and identify the most impactful E&S disclosure mandate within each country during our sample period.[29] We re-estimate equation (4) with *Mandate Comp* as the key independent variable and report the results in Panel B of Table 7. Similar to our findings on voluntary reporting frameworks, we document a positive association between the amount of E&S disclosure (*Length*) and the implementation of mandatory E&S disclosure regulations. However, in contrast to our results on voluntary reporting frameworks, the quality of E&S disclosure seems to deteriorate after E&S disclosure becomes mandatory. Specifically, firms provide more generic (*Boilerplate*) and less specific (*Specificity*) information.[30] In addition, E&S disclosure stickiness also increases following these mandates, likely because firms are required to provide similar information year-over-year.

[28] Another possibility is that we identify and test the effects of the first mandates within our sample period, which is not necessarily the same as the first E&S disclosure mandate in the country's history. For example, as early as 1996, Belgium started to require companies to issue "Social Balance Sheets" including information related to social matters (e.g., employees). Since our annual report sample begins in 2001, we are only able to capture the first mandate issued during our sample period, which may have a limited effect.
[29] 20 of the 23 countries with disclosure mandates begin with (or switch to) integrated E&S disclosures in annual reports, although a few countries give firms the flexibility to choose their disclosure channel. Only 3 of the 30 countries (i.e., Hong Kong, Singapore, and Norway) in our sample have specifically mandated standalone ESG reports. In an untabulated robustness test, we repeat the analysis in Table 7 using only integrated E&S disclosure mandates and document similar results.
[30] When replacing *Specificity* with the absolute word count of E&S sentences containing specific information, we do not observe any significant change in E&S disclosure specificity. We caution the reader that the significant decline in *Specificity* surrounding the most comprehensive mandate documented in our main analysis only reflects a decrease in specific E&S words relative to the total number of words in E&S-related disclosures.

There are two possible explanations for this result. First, it is possible that firms previously resisting E&S disclosure are forced to disclose after the mandates, and provide low-quality information. Second, firms with existing voluntary E&S reporting practices might lower their disclosure quality once the mandates are in place because there is less differentiation when all firms are forced to report. In Table OA.7, we construct a constant sample by only including firms offering E&S disclosures both before and after the mandate in each country and continue to observe similar decreases in E&S disclosure quality following the mandate, suggesting that our results are at least not entirely attributable to changes in sample composition. Moreover, the sharp contrast between the adoption effects of voluntary frameworks and disclosure mandates is to some extent consistent with prior literature that uses firm-level reporting incentives to explain the cross-sectional variation in the adoption effects of accounting standards (e.g., Daske et al. 2013; Cascino and Gassen 2015). Similar to findings documented in these studies, firms that voluntarily adopt ESG reporting frameworks are likely those that enjoy net benefits from disclosing high quality E&S information, while E&S disclosure mandates tend to force firms that previously did not disclose much E&S information to start disclosing such information, which is likely to be of lower quality. Therefore, we caution readers that our results regarding voluntary frameworks and disclosure mandates may reflect the joint effects of firms' underlying reporting incentives and the adoption of voluntary frameworks or disclosure mandates. Altogether, our findings imply that existing E&S mandates may have limited effects on E&S disclosure quality because factors other than standards (e.g., managerial incentives and other institutional arrangements) appear to play a more important role in shaping E&S reporting practices (see Christensen et al. 2021).[31]

[31] Although we do not claim causality when documenting the changes in E&S disclosure surrounding the adoption of voluntary frameworks and disclosure mandates, we perform falsification tests using pseudo-

5. Conclusion

This study examines the evolution of E&S disclosure in annual reports and assesses the roles that voluntary ESG reporting frameworks and mandatory disclosure regulations have played in shaping the current state of E&S disclosure. We apply the word embedding model to over 210,000 annual reports published between 2001 and 2020 for 24,271 publicly listed firms in 30 countries to create an E&S keyword dictionary. We then construct a broad set of textual disclosure attributes to proxy E&S disclosure quantity and quality in annual reports. We document marked trends unique to E&S disclosure in annual reports from 2001 to 2020. First, we document a significant increase in the amount of E&S disclosure, although E&S disclosure has also become more generic and less specific over time. Second, our results based on several E&S disclosure attributes suggest that the quality of E&S disclosure improves after the adoption of voluntary ESG reporting frameworks but deteriorates after our sample countries' major E&S disclosure mandates, and these results are at least not entirely attributable to sample composition changes (i.e., more firms start to disclose E&S information).

Our study is subject to a few important caveats. First, the evidence we provide is descriptive and based on associations. Therefore, we are not able to draw causal inferences. Second, we focus on the evolution of E&S disclosure in a single disclosure channel (i.e., annual reports) and cannot directly speak to how E&S disclosure in other disclosure channels may have evolved over time (e.g., ESG reports). However, when controlling for the existence of a stand-alone ESG report in our analyses, we find that the two disclosure channels (i.e., annual report and

event dates to rule out the alternative explanation that our main results simply reflect the differential time trends between treated firms and control firms. Specifically, for the ESG voluntary framework analysis, we randomly assign firms to the voluntary ESG reporting framework pseudo-adoption group. As for the E&S disclosure mandate test, we randomly assign an effective year of the most comprehensive E&S disclosure mandate to each firm with a uniform distribution between 2001 and 2020. In Table OA.8, we do not observe any significant changes in E&S disclosure attributes surrounding these pseudo-event dates in either analysis.

stand-alone ESG report) seem to complement rather than substitute for one another. Finally, our technique only allows us to examine English-language annual reports, which raises the potential concern that some firms from non-English speaking countries in our sample self-select into issuing English-language annual reports. Overall, though, we believe our study provides informative and systematic evidence that advances our understanding of the development and evolution of E&S disclosure in annual reports across the globe.

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Appendix. Variable definitions

VARIABLES	DEFINITION	SOURCE
E&S Disclosure Variables		
Length	The total number of words from E&S-related sentences divided by 1000. E&S-related sentences are defined as those containing words from the E&S dictionary developed using *Word2Vec*.	Refinitiv Global Filings
Boilerplate	The number of boilerplate sentences identified, scaled by the number of E&S-related sentences as a percentage. E&S-related sentences are defined as those containing words from the E&S dictionary developed using *Word2Vec*.	Refinitiv Global Filings
Specificity	The number of words in E&S-related sentences conveying specific names of persons, locations, and organizations; quantitative values in money values and percentages; and dates and times, scaled by the total number of words in E&S-related sentences in percentage. E&S-related sentences are defined as those containing words from the E&S dictionary developed using *Word2Vec*. Specific names are identified by Named entity recognition (NER).	Refinitiv Global Filings
Stickiness	The textual cosine similarity between a firm's E&S-related disclosures in year *t* and *t*-1 as a percentage. E&S-related sentences are defined as those containing words from the E&S dictionary developed using *Word2Vec*.	Refinitiv Global Filings
Visual	The total number of tables and figures used in E&S-related disclosures. We identify E&S-related tables as those that include E&S keywords from our dictionary, and we classify a figure as E&S-related if it appears within 300 words before or after an E&S-related sentence.	Refinitiv Global Filings
Firm Characteristics		
Analyst coverage	The natural logarithm of one plus the number of analysts following the firm.	I/B/E/S
ESG rating	A dummy variable that takes the value of one if the firm is covered by Refinitiv Asset4 ESG rating in the year, and zero otherwise.	Refinitiv ESG
ESG report	A dummy variable that takes the value of one if the firm issues a separate ESG report in the year, and zero otherwise.	Refinitiv Global Filings
Firm returns	The firm's annual cumulative return.	Datastream

Firm return volatility	The standard deviation of the firm's monthly returns.	Datastream
Inst ownership	The percentage of the firm's institutional ownership.	Refinitiv ownership
Leverage	The firm's total debt scaled by its total assets.	Worldscope
ROA	Net income before extraordinary items scaled by the total assets.	Worldscope
Size	The natural logarithm of total assets.	Worldscope
Tobin's Q	The market value of equity plus the book value of liabilities scaled by book value of assets.	Worldscope
Total words	The natural logarithm of the total number of words in a firm's annual report.	Refinitiv Global Filings
Total boilerplate	The number of boilerplate sentences identified, scaled by the number of all sentences as a percentage throughout the entire annual report.	Refinitiv Global Filings
Total specificity	The number of words conveying specific names of persons, locations, and organizations; quantitative values in money values and percentages; and dates and times, scaled by the total number of words in the annual report. Specific names are identified by Named entity recognition (NER).	Refinitiv Global Filings
Total stickiness	The textual cosine similarity between a firm's annual report in year *t* and *t*-1 as a percentage.	Refinitiv Global Filings
Total visual	The total number of tables and figures used in annual reports.	Refinitiv Global Filings
Country Characteristics		
Environmental factors		
Forest pct	Forest area as percentage of land area.	World Bank
GHG per capita	Total greenhouse gas emission scaled by population.	World Bank
Natural resource rent	The sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents as percentage of GDP estimated by World Bank.	World Bank
Renewable energy	Renewable energy consumption as percentage of total final energy consumption.	World Bank
Social factors		World Bank
Female labor pct	The percentage of women above 15 that are active in the labor force.	World Bank
Life expectancy	Life expectancy at birth (years).	World Bank
Population	The logarithm of total population.	World Bank
Rule of law	The extent to which agents have confidence in and abide by the rules of society.	World Bank
Unemployment	Unemployment as percentage of total labor force (modeled ILO estimate).	World Bank

Market forces		
Agriculture pct	Agriculture, forestry, and fishing, value added as a percentage of GDP.	World Bank
GDP growth	Annual growth rate of GDP.	World Bank
GDP per capita	GDP per capita.	World Bank
Market cap / GDP	Total market capitalization of listed domestic firms divided by the total GDP of a country provided by the World Bank. We replace missing values with the total market capitalization calculated using all firms from a country in Worldscope divided by total GDP.	World Bank & Worldscope
Opaqueness	The country's rank of overall earnings management engagement following Leuz et al. (2003).	Worldscope
Voluntary Framework		
Framework	A dummy variable that takes the value of one if the firm has mentioned any of the major ESG reporting frameworks in its annual report, and zero otherwise.	Textual analysis
Disclosure Mandate		
Mandate First	A dummy variable that takes the value of one if the first E&S disclosure mandate during our sample period for the country has become effective, and zero otherwise.	Hand collected
Mandate Comp	A dummy variable that takes the value of one if the most comprehensive E&S disclosure mandate during our sample period for the country has become effective, and zero otherwise.	Hand collected

Table 1. Sample construction and distribution

Panel A of this table presents our sample construction process. Panel B of this table lists the countries included in this study and the number of available annual reports from every country in our sample period and in each of the subperiods: 2001-2005, 2006-2010, 2011-2015, and 2016-2020.

Panel A: Sample construction

Sample Filter	# annual reports	# annual reports / obs. removed	# firm-year obs.	# unique firms
Download annual report files from Refinitiv	274,413			
Annual reports matched with WorldScope data	234,473	39,940		
Keep PDF files that can be parsed	227,669	6,804		
Keep one annual report per firm-year from 2001 to 2020	217,422	10,247	217,422	24,271
Obs with non-missing country-level variables*	183,271		183,271	22,588
Obs with non-missing firm-level variables*	174,071		174,071	20,579
Obs with non-missing country- and firm-level variables	157,821	59,601	157,821	19,970

* Obs. with non-missing firm-level variables may have country-level variables missing.

Table 1. Sample construction and distribution (Cont.)

Panel B: Sample distribution

Country	No. of Annual Reports in Subperiod				
	2001~2005	2006~2010	2011~2015	2016~2020	2001~2020
Australia	5,605	8,932	9,158	9,227	32,922
Austria	255	325	271	231	1,082
Belgium	382	466	399	457	1,704
Canada	4,866	4,660	2,850	2,318	14,694
China	683	857	824	1,371	3,735
Denmark	278	444	432	523	1,677
Finland	473	433	512	580	1,998
France	682	858	994	1,263	3,797
Germany	1,537	1,842	1,589	1,644	6,612
Greece	324	378	291	285	1,278
Hong Kong	792	873	796	1,007	3,468
India	2,439	10,223	12,666	14,166	39,494
Indonesia	888	1,381	986	234	3,489
Ireland	287	345	289	309	1,230
Italy	686	773	656	839	2,954
Japan	1,372	248	808	1,713	4,141
Malaysia	3,914	3,629	4,220	4,279	16,042
Netherlands	579	612	563	632	2,386
New Zealand	524	584	650	677	2,435
Nigeria	74	342	448	593	1,457
Norway	410	640	604	711	2,365
Pakistan	601	1,222	1,516	1,729	5,068
Russian Federation	168	624	509	372	1,673
Singapore	2,160	2,975	2,952	2,886	10,973
South Africa	1,529	1,619	1,429	1,315	5,892
Sri Lanka	268	894	1,177	1,172	3,511
Sweden	650	818	1,001	1,624	4,093
Switzerland	842	967	942	983	3,734
Turkey	340	606	505	428	1,879
United Kingdom	8,441	8,516	7,331	7,351	31,639
Total	42,049	57,086	57,368	60,919	217,422

Table 2. Seed word list and representative dictionary words

This table presents the seed words in each category for both the *Environmental* and *Social* dimensions. The classification of categories is based on the combination of the MSCI ESG rating framework (MSCI 2022b) and GAO ESG categories (GAO 2020). We follow the CDSB framework for reporting environmental & social information, GRI standards 2021, IIRC framework 2021, SASB materiality map 2021, and TCFD Guidance on metrics, targets, and transition plans 2021 to generate the seed words.

Dimension	Category	Seed Words	Top 20 Representative Words
Environmental	Climate Change	carbon footprint, co2 emission, climate change, GHG emission, global warming, greenhouse gas, Scope 1, Scope 2, Scope 3	emission, climate, climate change, greenhouse gas, co2 emission, carbon, co2, carbon footprint, carbon emission, GHG emission, SDG, carbon dioxide, warming, sustainability performance, emission reduction, co2e, emission factor, energy transition, tco2e, scope 1
	Natural Resources	electricity consumption, fossil fuel, heating consumption, steam consumption, water consumption, gas consumption	gas, oil, water, consumption, electricity, fuel, coal, energy consumption, production volume, wood, water consumption, kwh, energy saving, diesel, energy source, heating, steam, fuel consumption, electricity consumption, mwh
	Pollution & Waste	air pollution, air quality, particulate matter, pollution, hazardous waste, noise pollution, landfill, waste water, waste	waste, transport, chemical, packaging, plastic, recycling, energy efficiency, hazardous, pollution, soil, waste management, reuse, hazard, effluent, water treatment, water supply, landfill, noise, waste water, harmful
	Ecosystem	biodiversity, deforestation, natural habitat, reforestation, fauna and flora, ecosystem	conservation, urban, landscape, ecosystem, ecological, forest, biodiversity, specie, palm oil, heritage, planet, planting, river, water resource, habitat, ocean, wild, flora, fauna, animal welfare

Table 2. Seed word list and representative dictionary words (Cont.)

Dimension	Category	Seed Words	Top 20 Representative Words
Social	Human Capital	career development, diversity and inclusion, employee engagement, gender diversity, health and safety, human capital, human right, forced labor, slavery	ethical, workforce, talent, workplace, ethic, gender, colleague, discrimination, work environment, nurture, employee engagement, gender diversity, motivation, career development, equality, working environment, diversity policy, business ethic, performance management, board diversity
	Products & Customers	consumer privacy, customer privacy, customer welfare, data protection, responsible marketing, product quality, supply chain sustainability	technological, reliability, reputation, productivity, product development, supply chain, customer service, competitiveness, customer satisfaction, stringent, product range, legislative, information system, production process, ingredient, functionality, quality control, customer experience, confidentiality, quality product
	Other Stakeholders	community relation, local community, social capital, community engagement, corruption, bribery	corruption, citizen, violation, business partner, offence, cultural, educational, misconduct, harassment, bribery, criminal, illegal, welfare, unethical, socially, well-being, wellbeing, indigenous, youth, stakeholder engagement

Table 3. Descriptive statistics

This table provides summary statistics for our sample. The definitions and sources of the variables are available in the Appendix.

Variables	Mean	P1	P25	Median	P75	P99	Std.
Disclosure Variables							
Length	1.357	0.000	0.266	0.666	1.585	11.087	1.908
Boilerplate	12.927	0.000	3.704	8.824	17.949	75.000	13.658
Specificity	5.439	0.000	3.814	5.224	6.821	15.663	2.812
Stickiness	94.406	49.119	94.279	97.903	99.164	99.982	9.084
Visual	9.233	0.000	1.000	4.000	11.000	85.000	14.421
Total length	23.842	0.596	11.828	18.819	30.303	99.619	18.276
Total boilerplate	19.572	0.286	12.749	18.559	25.806	42.652	9.360
Total specificity	8.847	5.085	7.449	8.442	9.634	20.169	2.360
Total stickiness	97.999	73.415	98.639	99.504	99.778	99.960	4.306
Total visual	122.710	9.000	55.000	87.000	147.000	711.000	114.895
Firm Characteristics							
Analyst coverage	0.702	0.000	0.000	0.000	1.099	3.258	0.951
ESG rating	0.127	0.000	0.000	0.000	0.000	1.000	0.333
ESG report	0.033	0.000	0.000	0.000	0.000	1.000	0.179
Firm returns	0.186	-0.862	-0.252	0.026	0.362	4.603	0.810
Firm return volatility	0.038	0.006	0.020	0.030	0.045	0.190	0.030
Inst ownership	0.051	0.000	0.000	0.001	0.064	0.474	0.094
Leverage	0.221	0.000	0.012	0.163	0.342	1.332	0.242
ROA	-0.057	-2.457	-0.030	0.023	0.067	0.332	0.358
Size	20.092	12.991	17.842	19.926	22.068	28.826	3.246
Tobin's Q	1.770	0.357	0.909	1.146	1.780	14.392	1.978

Table 3. Descriptive statistics (Cont.)

Variables	Mean	P1	P25	Median	P75	P99	Std.
Country Characteristics							
Environmental factors							
Forest pct	28.019	5.143	16.952	23.553	33.626	68.827	16.276
GHG per capita	11.218	1.426	4.438	9.564	13.241	31.513	8.377
Natural resource rent	3.107	0.000	0.433	1.991	4.741	13.761	3.266
Renewable energy	17.837	0.200	4.440	10.190	32.820	61.850	16.171
Social factors							
Female labor pct	48.332	20.526	43.495	54.647	58.614	63.816	13.807
Life expectancy	76.277	53.795	69.656	79.490	81.305	83.985	6.860
Population	17.956	15.243	16.892	17.767	18.777	21.035	1.743
Rule of law	1.010	-0.958	0.053	1.608	1.756	1.990	0.896
Unemployment	6.091	0.800	4.430	5.414	6.140	28.340	3.958
Market forces							
Agriculture pct	6.049	0.032	0.916	2.286	9.969	23.710	6.769
GDP growth	3.704	-4.247	2.115	3.110	5.456	9.940	2.642
GDP per capita	28.711	0.628	3.844	32.144	45.405	84.776	22.282
Market Cap / GDP	112.819	13.731	68.270	103.500	128.836	886.115	97.916
Opaqueness	2.101	1.108	1.697	2.135	2.446	3.371	0.481

Table 4. Country- and firm-level factors of E&S disclosure

This table presents empirical results on the factors of E&S disclosure in annual reports. The empirical model is:

$$ES\ disclosure = \beta_0 + \beta_1 \times Environmental\ Factors + \beta_2 \times Social\ Factors + \beta_3 \times Market\ Forces + \beta_4 \times Firm\ Chars + \varepsilon \quad (1)$$

where *ES disclosure* is *Length*, *Boilerplate, Specificity*, *Stickiness*, and *Visual*. Environmental factors include *Forest pct*, *GHG per capita*, *Natural resource rent*, and *Renewable energy*. Social factors include *Female labor pct*, *Life expectancy*, *Population*, *Rule of Law*, and *Unemployment*. Market forces include *Agriculture pct*, *GDP growth*, *GDP per capita*, *Market cap / GDP*, and *Opaqueness*. Firm characteristics include *Analyst coverage*, *ESG rating*, *ESG report, Firm returns*, *Firm return volatility*, *Institutional ownership*, *Leverage*, *ROA*, *Size*, *Tobin's Q*, and *Total words*. We also control for *Total boilerplate*, *Total specificity*, *Total stickiness*, or *Total visual* in the regression when the corresponding ESG disclosure attribute is the dependent variable. The definitions and sources of the variables are available in the Appendix. Panel A reports the results of *Length*, and Panel B reports the results of other disclosure attributes. The standard errors are clustered at the country level and reported in parentheses. ***, **, and * indicate significant levels at 1%, 5%, and 10%, respectively.

Panel A: E&S disclosure quantity

Dependent variable:			*Length*		
	(1)	(2)	(3)	(4)	(5)
Environmental factors					
Forest pct	0.006		-0.007	-0.030	-0.032
	(0.007)		(0.005)	(0.026)	(0.138)
GHG per capita	-0.033		-0.010	0.099***	0.117***
	(0.020)		(0.016)	(0.021)	(0.016)
Natural resource rent	-0.002		0.025	-0.001	-0.004
	(0.033)		(0.029)	(0.027)	(0.029)
Renewable energy	0.011		0.013***	0.051***	0.037***
	(0.008)		(0.004)	(0.014)	(0.012)
Social factors					
Female labor pct	0.010		0.004	0.016	0.022
	(0.010)		(0.012)	(0.014)	(0.016)
Life expectancy	0.152***		0.095*	0.098*	0.099*
	(0.056)		(0.049)	(0.058)	(0.055)
Population	0.223***		0.121**	-0.203	-4.199**
	(0.054)		(0.047)	(0.168)	(1.609)
Rule of law	-0.939***		-0.298	-0.024	-0.140
	(0.215)		(0.199)	(0.240)	(0.305)
Unemployment	0.096*		0.052	-0.014	0.001
	(0.056)		(0.048)	(0.023)	(0.023)
Market forces					
Agriculture pct	-0.042		-0.037	-0.095**	-0.092*
	(0.047)		(0.041)	(0.038)	(0.051)
GDP growth	-0.067***		-0.027*	0.016	0.004
	(0.018)		(0.014)	(0.010)	(0.009)
GDP per capita	0.008		-0.012***	-0.015***	-0.010**
	(0.007)		(0.004)	(0.003)	(0.004)
Market Cap / GDP	0.003*		0.002*	-0.002**	-0.000
	(0.001)		(0.001)	(0.001)	(0.001)

Table 4. Country- and firm-level factors of E&S disclosure (Cont.)

Panel A: E&S disclosure quantity (Cont.)

Dependent variable:			*Length*		
	(1)	(2)	(3)	(4)	(5)
Opaqueness	-0.507**		-0.354**	0.028	0.037
	(0.190)		(0.143)	(0.078)	(0.053)
Firm characteristics					
Analyst coverage		0.212***	0.248***	0.249***	0.056
		(0.061)	(0.059)	(0.055)	(0.033)
ESG rating		0.949***	0.901***	0.792***	0.663***
		(0.204)	(0.175)	(0.159)	(0.161)
ESG report		0.592***	0.542***	0.550***	0.171
		(0.120)	(0.123)	(0.116)	(0.117)
Firm returns		-0.013*	-0.014	-0.002	0.001
		(0.007)	(0.010)	(0.008)	(0.006)
Firm return volatility		0.245	0.934	2.036**	0.521
		(0.981)	(1.065)	(0.839)	(0.450)
Inst ownership		1.460***	1.090**	0.600	2.065***
		(0.473)	(0.407)	(0.365)	(0.495)
Leverage		-0.046	-0.081	-0.147**	-0.101***
		(0.078)	(0.067)	(0.055)	(0.023)
ROA		-0.075	-0.103**	-0.115***	-0.019
		(0.045)	(0.038)	(0.031)	(0.014)
Size		0.068***	0.050**	0.098***	0.059*
		(0.020)	(0.020)	(0.013)	(0.030)
Tobin Q		0.023**	0.013	0.020**	0.012
		(0.011)	(0.009)	(0.007)	(0.007)
Total words		1.055***	1.057***	0.947***	0.804***
		(0.126)	(0.143)	(0.136)	(0.130)
Country FE	No	No	No	Yes	No
Firm FE	No	No	No	No	Yes
Year FE	No	No	No	Yes	Yes
Obs.	183,271	174,071	157,821	157,820	155,317
Adj. R^2	0.133	0.491	0.521	0.570	0.772

Table 4. Country- and firm-level factors of E&S disclosure (Cont.)

Panel B: Other E&S disclosure attributes

Dependent variable:	*Boilerplate*		*Specificity*		*Stickiness*		*Visual*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Environmental factors								
Forest pct	0.118	-0.085	0.016	0.114	-0.106	-0.921***	-0.234**	-0.718
	(0.098)	(0.324)	(0.020)	(0.101)	(0.070)	(0.262)	(0.094)	(0.430)
GHG per capita	0.031	-0.007	-0.169***	-0.158***	0.229***	0.203***	0.279*	0.354**
	(0.180)	(0.207)	(0.028)	(0.022)	(0.067)	(0.072)	(0.137)	(0.136)
Natural resource rent	-0.111	-0.103	0.061*	0.055*	-0.023	-0.073*	0.203	0.131
	(0.229)	(0.195)	(0.030)	(0.032)	(0.041)	(0.043)	(0.189)	(0.186)
Renewable energy	-0.107	-0.024	0.013	-0.002	-0.011	0.039	0.291***	0.320**
	(0.096)	(0.123)	(0.010)	(0.013)	(0.041)	(0.070)	(0.093)	(0.136)
Social factors								
Female labor pct	-0.599***	-0.563***	0.038**	0.049***	0.199***	0.109	0.297**	0.221*
	(0.147)	(0.135)	(0.018)	(0.017)	(0.057)	(0.070)	(0.115)	(0.127)
Life expectancy	-0.014	0.114	0.088	0.089	0.150*	-0.005	0.606*	0.527
	(0.547)	(0.551)	(0.088)	(0.105)	(0.088)	(0.094)	(0.350)	(0.346)
Population	1.464	5.695	-0.099	-1.008	0.493	3.701	2.270	-1.879
	(1.418)	(9.094)	(0.218)	(2.488)	(1.075)	(5.694)	(1.369)	(10.870)
Rule of law	1.711	1.384	0.145	0.233	-0.462	-1.962	-0.022	-0.726
	(1.846)	(1.943)	(0.305)	(0.333)	(1.655)	(1.816)	(1.355)	(1.343)
Unemployment	-0.258	-0.262*	0.018	0.028	0.054	0.068	-0.011	0.008
	(0.174)	(0.151)	(0.036)	(0.032)	(0.082)	(0.050)	(0.159)	(0.143)
Market forces								
Agriculture pct	0.290	0.238	-0.010	0.014	0.012	-0.203*	-0.409	-0.656**
	(0.279)	(0.301)	(0.059)	(0.062)	(0.111)	(0.103)	(0.325)	(0.271)
GDP growth	-0.069	-0.066	0.009	0.005	0.053	0.069**	-0.000	-0.034
	(0.094)	(0.083)	(0.016)	(0.017)	(0.041)	(0.033)	(0.063)	(0.056)
GDP per capita	0.059	0.038	-0.005	0.000	-0.006	-0.009	-0.071**	-0.064
	(0.050)	(0.053)	(0.006)	(0.008)	(0.014)	(0.017)	(0.035)	(0.038)
Market cap / GDP	0.005	0.001	0.001	0.001	-0.004	-0.002	0.003	0.004
	(0.009)	(0.009)	(0.001)	(0.001)	(0.003)	(0.003)	(0.009)	(0.008)
Opaqueness	0.317	0.233	-0.074	-0.086	-0.379	-0.193	-0.008	0.145
	(0.506)	(0.541)	(0.110)	(0.088)	(0.243)	(0.231)	(0.512)	(0.443)

Table 4. Country- and firm-level factors of E&S disclosure (Cont.)

Panel B: Other E&S disclosure attributes (Cont.)

Dependent variable:	*Boilerplate*		*Specificity*		*Stickiness*		*Visual*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm characteristics								
Analyst coverage	-0.171*	-0.026	-0.005	0.001	0.438***	0.003	1.401***	0.281**
	(0.089)	(0.103)	(0.036)	(0.024)	(0.137)	(0.092)	(0.291)	(0.107)
ESG rating	0.401	-1.551***	0.094	0.159**	-0.243	-0.463	2.147***	1.473**
	(0.902)	(0.315)	(0.068)	(0.077)	(0.207)	(0.302)	(0.507)	(0.609)
ESG report	-0.482	-0.945*	0.163**	0.145*	-0.255	-0.112	1.215**	-0.366
	(0.408)	(0.468)	(0.070)	(0.075)	(0.152)	(0.143)	(0.584)	(0.581)
Firm returns	-0.125*	-0.041	0.014	-0.004	0.041	0.062	0.088**	0.018
	(0.063)	(0.053)	(0.018)	(0.016)	(0.052)	(0.061)	(0.033)	(0.031)
Firm return volatility	7.368	2.398	-0.066	-0.261	-8.235***	-6.032***	-7.558	-2.906
	(6.301)	(2.418)	(1.062)	(0.389)	(1.719)	(1.897)	(6.211)	(1.805)
Inst ownership	0.968	1.166	-0.967***	-0.012	-0.197	-0.716	1.803	8.500***
	(1.624)	(0.942)	(0.270)	(0.241)	(0.508)	(0.695)	(2.117)	(2.110)
Leverage	0.437*	0.474	-0.001	-0.125**	-0.168	-0.037	-0.371	-0.561***
	(0.235)	(0.305)	(0.142)	(0.059)	(0.208)	(0.127)	(0.412)	(0.179)
ROA	-0.296	-0.238**	-0.070***	0.053*	0.726***	0.180**	0.278	0.280***
	(0.215)	(0.102)	(0.025)	(0.029)	(0.141)	(0.084)	(0.305)	(0.053)
Size	0.292*	-0.058	0.005	-0.014	-0.103	0.196	-0.056	0.026
	(0.149)	(0.132)	(0.017)	(0.018)	(0.063)	(0.166)	(0.072)	(0.105)
Tobin Q	0.041	0.026	-0.022***	0.006	0.018	-0.032	0.073	0.071*
	(0.047)	(0.037)	(0.004)	(0.006)	(0.019)	(0.038)	(0.052)	(0.036)
Total words	-2.993***	-3.417***	1.085***	1.191***	3.188***	2.887***	0.637	0.115
	(0.934)	(0.906)	(0.115)	(0.150)	(0.470)	(0.648)	(0.615)	(0.508)
Total boilerplate	0.821***	0.785***						
	(0.051)	(0.034)						
Total specificity			0.339***	0.296***				
			(0.045)	(0.042)				
Total stickiness					1.107***	1.113***		
					(0.090)	(0.088)		
Total visual							0.077***	0.077***
							(0.004)	(0.003)

Table 4. Country- and firm-level factors of E&S disclosure (Cont.)

Panel B: Other E&S disclosure attributes (Cont.)

Dependent variable:	*Boilerplate*		*Specificity*		*Stickiness*		*Visual*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Country FE	Yes	No	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	154,512	152,088	157,820	155,317	113,500	111,231	157,753	155,250
Adj. R^2	0.392	0.568	0.173	0.397	0.363	0.476	0.491	0.625

Table 5. Evolution of E&S disclosure attributes

This table presents empirical results on the evolution of E&S disclosure attributes over time. The empirical model is:

$$ES\ disclosure = \beta_0 + \beta_1 \times Trend + \beta_2 \times Environmental\ Factors + \beta_3 \times Social\ Factors + \beta_4 \times Market\ Forces + \beta_5 \times Firm\ Chars + \varepsilon \quad (2)$$

where *ES disclosure* is *Length*, *Boilerplate, Specificity*, *Stickiness*, and *Visual*. *Trend* is the year of the annual report minus 2000. In Panel A, we report the overall trend in E&S disclosure. In Panel B, we interact *Trend* with indicators for Fama-French 5 industries. In both panels, environmental factors include *Forest pct*, *GHG per capita*, *Natural resource rent*, and *Renewable energy*. Social factors include *Female labor pct*, *Life expectancy*, *Population*, *Rule of Law*, and *Unemployment*. Market forces include *Agriculture pct*, *GDP growth*, *GDP per capita*, *Market cap / GDP*, and *Opaqueness*. Firm characteristics include *Analyst coverage*, *ESG rating*, *ESG report, Firm returns*, *Firm return volatility*, *Institutional ownership*, *Leverage*, *ROA*, *Size*, *Tobin's Q*, and *Total words*. We also control for *Total boilerplate*, *Total specificity*, *Total stickiness*, or *Total visual* in the regression when the corresponding ESG disclosure attribute is the dependent variable. The definitions and sources of the variables are available in the Appendix. The standard errors are clustered at the country level and reported in parentheses. ***, **, and * indicate significant levels at 1%, 5%, and 10%, respectively.

Panel A: Overall trend in E&S disclosure

Dependent variable:	*Length*	*Boilerplate*	*Specificity*	*Stickiness*	*Visual*
	(1)	(2)	(3)	(4)	(5)
Trend	0.117***	0.314**	-0.097**	0.058	0.203
	(0.021)	(0.141)	(0.036)	(0.062)	(0.181)
Total boilerplate		0.786***			
		(0.036)			
Total specificity			0.300***		
			(0.046)		
Total stickiness				1.120***	
				(0.094)	
Total visual					0.077***
					(0.003)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No
Obs.	155,317	152,088	155,317	111,231	155,250
Adj. R^2	0.768	0.567	0.395	0.475	0.623

Table 5. Evolution of E&S disclosure attributes (Cont.)

Panel B: E&S disclosure trends by industry

Dependent variable:	*Length*	*Boilerplate*	*Specificity*	*Stickiness*	*Visual*
	(1)	(2)	(3)	(4)	(5)
*Trend * Consumer*	0.117***	0.323**	-0.110***	0.065	0.266
	(0.020)	(0.146)	(0.037)	(0.069)	(0.188)
*Trend * Manufacture*	0.132***	0.327**	-0.111***	-0.013	0.192
	(0.020)	(0.142)	(0.036)	(0.078)	(0.183)
*Trend * High Tech*	0.102***	0.342**	-0.079**	0.030	0.159
	(0.026)	(0.137)	(0.033)	(0.063)	(0.185)
*Trend * Health*	0.117***	0.316**	-0.108***	0.028	0.174
	(0.022)	(0.150)	(0.038)	(0.052)	(0.173)
*Trend * Other*	0.112***	0.279*	-0.084**	0.136**	0.200
	(0.022)	(0.138)	(0.036)	(0.059)	(0.179)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No
Obs.	155,317	152,088	155,317	111,231	155,250
Adj. R^2	0.769	0.567	0.395	0.475	0.623

Table 6. Voluntary ESG reporting frameworks and E&S disclosure

This table presents empirical results on the effects of voluntary ESG reporting frameworks on E&S disclosure attributes. The empirical model is:

$$ES\ disclosure = \beta_0 + \beta_1 \times Environmental\ Factors + \beta_2 \times Social\ Factors + \beta_3 \times Market\ Forces + \beta_4 \times Firm\ Chars + \beta_5 \times Framework + \varepsilon \quad (3)$$

where *ES disclosure* is *Length*, *Boilerplate, Specificity*, *Stickiness*, and *Visual*. In Panel A, *Framework* is a dummy variable which takes the value of one if a firm has adopted a voluntary ESG reporting framework, and zero otherwise. In Panel B, we compare the effects of six different voluntary frameworks (i.e., CDP; CDSB; GRI; IIRC; SASB; TCFD). Environmental factors include *Forest pct*, *GHG per capita*, *Natural resource rent*, and *Renewable energy*. Social factors include *Female labor pct*, *Life expectancy*, *Population*, *Rule of Law*, and *Unemployment*. Market forces include *Agriculture pct*, *GDP growth*, *GDP per capita*, *Market cap / GDP*, and *Opaqueness*. Firm characteristics include *Analyst coverage*, *ESG rating*, *ESG report, Firm returns*, *Firm return volatility*, *Institutional ownership*, *Leverage*, *ROA*, *Size*, *Tobin's Q*, and *Total words*. We also control for *Total boilerplate*, *Total specificity*, *Total stickiness*, or *Total visual* in the regression when the corresponding ESG disclosure attribute is the dependent variable. The definitions and sources of the variables are available in the Appendix. The standard errors are clustered at the country level and reported in parentheses. ***, **, and * indicate significant levels at 1%, 5%, and 10%, respectively.

Panel A: Voluntary framework and E&S disclosure

Dependent variable:	*Length*	*Boilerplate*	*Specificity*	*Stickiness*	*Visual*
	(1)	(2)	(3)	(4)	(5)
Framework	0.438***	-0.736***	0.006	0.630***	2.141***
	(0.103)	(0.196)	(0.047)	(0.205)	(0.476)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Obs.	155,317	152,088	155,317	111,231	155,250
Adj. R^2	0.777	0.568	0.397	0.477	0.627

Table 6. Voluntary ESG reporting frameworks and E&S disclosure (Cont.)

Panel B: Comparing voluntary ESG reporting frameworks

Dependent variable:	*Length*	*Boilerplate*	*Specificity*	*Stickiness*	*Visual*
	(1)	(2)	(3)	(4)	(5)
CDP	0.493***	-0.131	-0.072	-0.297*	1.988***
	(0.172)	(0.154)	(0.069)	(0.158)	(0.707)
CDSB	0.287***	0.949***	0.258	0.251	-0.167
	(0.091)	(0.344)	(0.242)	(0.260)	(1.577)
GRI	0.335***	-0.776***	0.023	0.739***	1.679***
	(0.089)	(0.237)	(0.045)	(0.196)	(0.439)
IIRC	0.757***	-0.497	0.346***	-0.193	7.430***
	(0.254)	(0.780)	(0.120)	(0.179)	(1.227)
SASB	0.606**	-0.384	0.269**	0.562	3.347***
	(0.232)	(0.337)	(0.108)	(0.460)	(1.136)
TCFD	1.534***	-0.219	-0.152	-0.061	7.433***
	(0.375)	(0.575)	(0.126)	(0.298)	(0.822)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Obs.	155,317	152,088	155,317	111,231	155,250
Adj. R^2	0.782	0.568	0.397	0.477	0.630

Table 7. Disclosure mandate and E&S disclosure

This table presents empirical results on the changes in E&S disclosure following disclosure mandates. The empirical model is as follows:

$$ES\ Disclosure = \beta_0 + \beta_1 \times Mandate + \beta_2 \times Environmental\ Factors + \beta_3 \times Social\ Factors + \beta_4 \times Market\ Forces + \beta_5 \times Firm\ Chars + \varepsilon \quad (4)$$

where *ES Disclosure* is *Length*, *Boilerplate, Specificity*, *Stickiness*, and *Visual*. *Mandate* is either an indicator that equals one after a country's first E&S disclosure mandate during our sample period has become effective ($Mandate\ First$) or an indicator that equals one after a country's most comprehensive E&S disclosure mandate during our sample period has become effective ($Mandate\ Comp$). Environmental factors include *Forest pct*, *GHG per capita*, *Natural resource rent*, and *Renewable energy*. Social factors include *Female labor pct*, *Life expectancy*, *Population*, *Rule of Law*, and *Unemployment*. Market forces include *Agriculture pct*, *Market cap / GDP*, *GDP growth*, *GDP per capita*, and *Opaqueness*. Firm characteristics include *Analyst coverage*, *ESG rating*, *ESG report, Firm returns*, *Firm return volatility*, *Institutional ownership*, *Leverage*, *ROA*, *Size*, *Tobin's Q*, and *Total words*. We also control for *Total boilerplate*, *Total specificity*, *Total stickiness*, or *Total visual* in the regression when the corresponding ESG disclosure attribute is the dependent variable. The definitions and sources of the variables are available in the Appendix. The standard errors are clustered at the country level and reported in parentheses. ***, **, and * indicate significant levels at 1%, 5%, and 10%, respectively.

Panel A: E/S disclosure changes around the first disclosure mandate

Dependent variable:	*Length*	*Boilerplate*	*Specificity*	*Stickiness*	*Visual*
	(1)	(2)	(3)	(4)	(5)
*Mandate First * Post*	0.026	-0.341	-0.150	0.135	-0.557
	(0.063)	(0.517)	(0.096)	(0.202)	(0.527)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Obs.	155,317	152,088	155,317	111,231	155,250
Adj. R^2	0.772	0.568	0.397	0.476	0.625

Table 7. Disclosure mandate and E&S disclosure (Cont.)

Panel B: E/S disclosure changes around the most comprehensive disclosure mandate

Dependent variable:	*Length*	*Boilerplate*	*Specificity*	*Stickiness*	*Visual*
	(1)	(2)	(3)	(4)	(5)
*Mandate Comp * Post*	0.251***	1.615*	-0.356**	0.550**	0.161
	(0.060)	(0.935)	(0.144)	(0.251)	(0.624)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Obs.	155,317	152,088	155,317	111,231	155,250
Adj. R^2	0.773	0.568	0.398	0.476	0.625

Figures for "Global Evolution of Environmental and Social Disclosure in Annual Reports"

Figure 1. The Evolution of E&S Disclosure Attributes

This figure displays the evolution of the five disclosure variables from 2001 to 2020. The x-axis is the year. From Panel A to Panel E, the y-axis is *E&S Length, Boilerplate*, *Specificity*, *Stickiness*, and *Visual*. Definitions are provided in the Appendix.

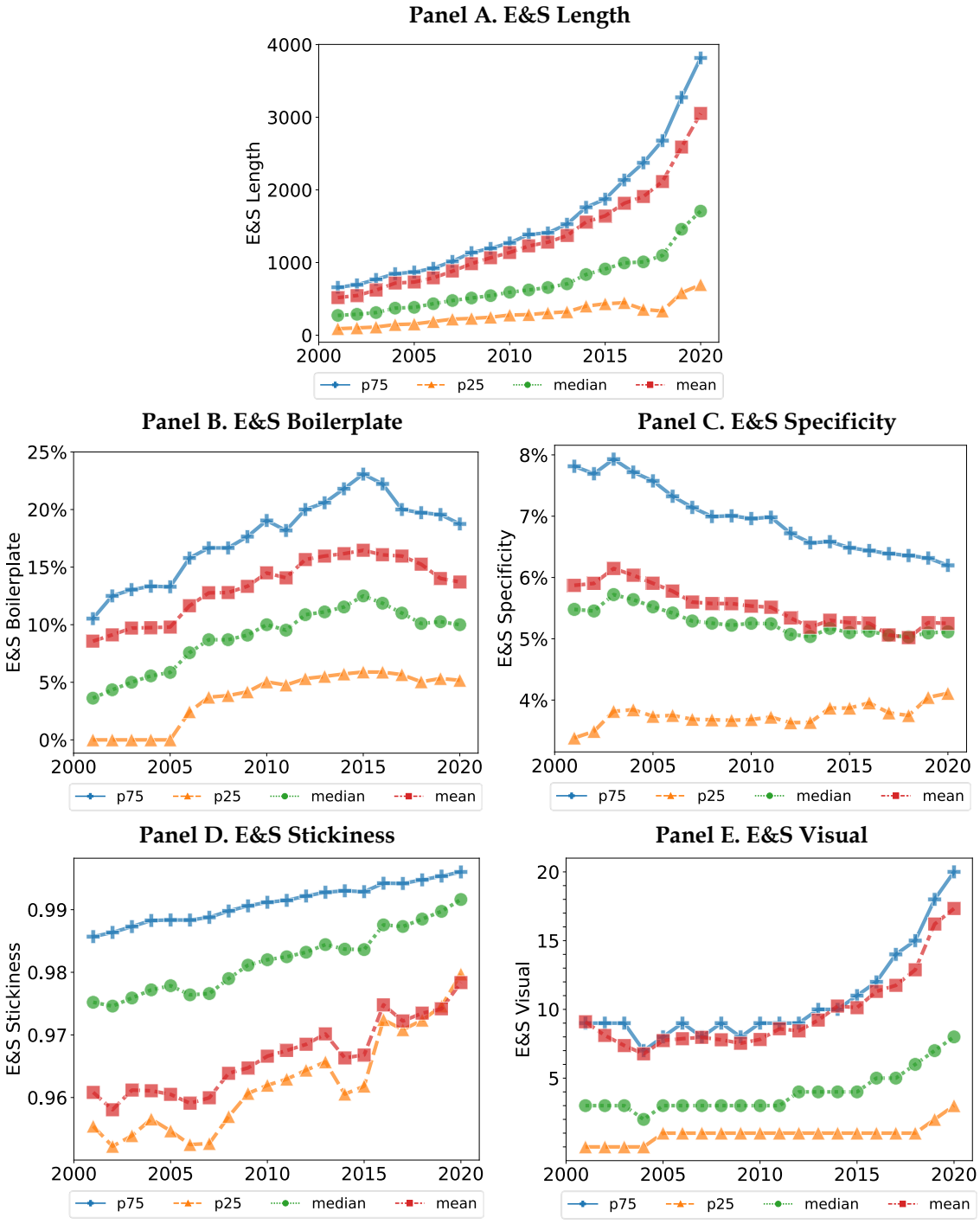
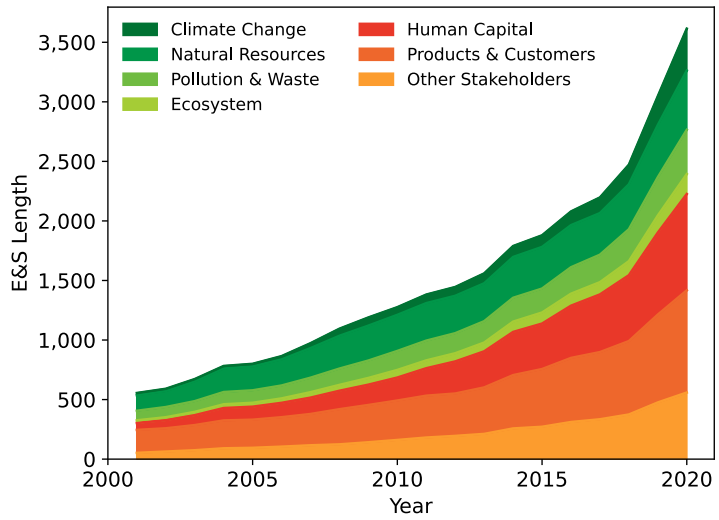


Figure 2. The Evolution of E&S Disclosure Length by Subtopic

This figure shows the evolution of E&S disclosure length for each E&S subtopic from 2001 to 2020. Panel A displays the annual medians of disclosure length for each E&S subtopic from 2001 to 2020. Panel B shows the relative importance of E&S subtopics in terms of percentage.

Panel A. E&S Length by Subtopic



Panel B. Relative Weight of E&S Length by Subtopic

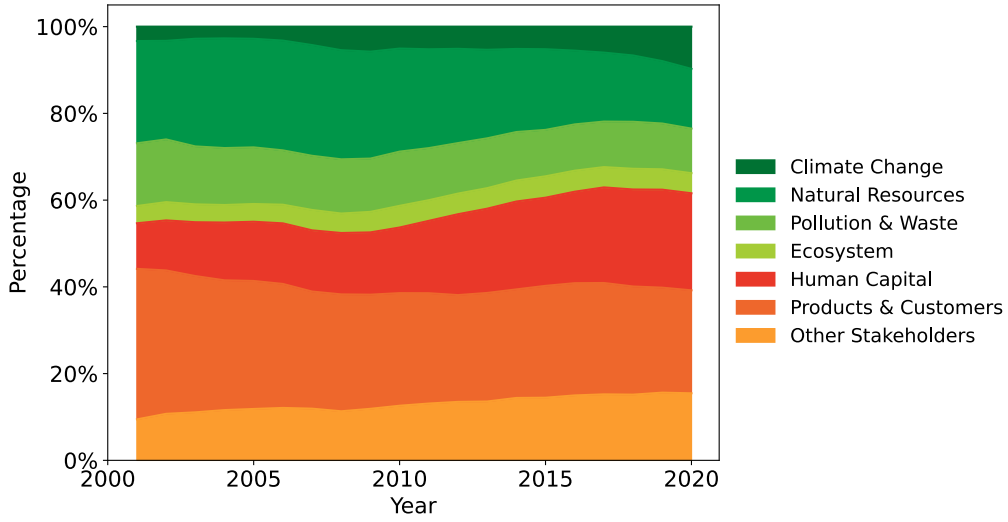


Figure 3. The Evolution of E&S Vocabulary

Panel A: Most Frequently Used E&S Vocabulary by Subperiod

Ranking	2001-2005	2006-2010	2011-2015	2016-2020
1	Gas	Gas	Gas	Ethical
2	Oil	Oil	Oil	Gas
3	Water	Ethical	Ethical	Oil
4	Ethical	Water	Water	Emission
5	Technological	Consumption	Consumption	Waste
6	Product development	Electricity	Waste	Water
7	Electricity	Fuel	Electricity	Workforce
8	Consumption	Waste	Emission	Consumption
9	Fuel	Technological	Workforce	Talent
10	Waste	Coal	Fuel	Electricity
11	Productivity	Reliability	Technological	Workplace
12	Transport	Transport	Reputation	Supply chain
13	Customer service	Emission	Reliability	Technological
14	Offence	Reputation	Talent	Corruption
15	Reliability	Product development	Coal	Reputation
16	Chemical	Productivity	Transport	Reliability
17	Reputation	Workforce	Productivity	Fuel
18	Workforce	Chemical	Product development	Gender
19	Coal	Talent	Workplace	Ethic
20	Product Range	Conservation	Ethic	Productivity

Climate Change
Natural Resources
Pollution & Waste
Ecosystem
Human Capital
Products & Customers
Other Stakeholders

Figure 3. The Evolution of E&S Vocabulary (Cont.)

Panel B: E&S Vocabulary with Largest Increase in Frequency of Usage

No.	Words and Phrases	Rank in 2001 ~ 2005	Rank in 2016 ~ 2020	Change in Rank
1	Energy Efficiency	100	44	+56
2	Greenhouse Gas	81	32	+49
3	Discrimination	96	48	+48
4	Carbon	98	54	+44
5	Violation	59	24	+35
6	Misconduct	95	60	+35
7	Illegal	97	68	+29
8	Workplace	38	11	+27
9	Work Environment	75	52	+23
10	Supply Chain	34	12	+22
11	Ethic	40	19	+21
12	Emission	23	4	+19
13	Talent	28	9	+19
14	Colleague	42	23	+19
15	Energy Consumption	44	26	+18
16	Confidentiality	78	65	+13
17	Workforce	18	7	+11
18	Landscape	83	73	+10
19	Conservation	41	33	+8
20	Recycling	45	37	+8

Climate Change
Natural Resources
Pollution & Waste
Ecosystem
Human Capital
Products & Customers
Other Stakeholders

Figure 3. The Evolution of E&S Vocabulary (Cont.)

Panel C: E&S Vocabulary with Largest Decrease in Frequency of Usage

No.	Words and Phrases	Rank in 2001-2005	Rank in 2016-2020	Change in Rank
1	Product Range	20	81	-61
2	Soil	50	99	-49
3	Product Offering	48	96	-48
4	Information System	29	76	-47
5	Functionality	36	80	-44
6	Motivation	56	100	-44
7	Quality Product	46	88	-42
8	Product Quality	51	89	-38
9	Offence	14	51	-37
10	Ingredient	37	74	-37
11	Manufacturing Process	58	92	-34
12	Customer Service	13	41	-28
13	Waste Management	62	87	-25
14	Welfare	55	78	-23
15	Product Development	6	27	-21
16	Competitiveness	22	43	-21
17	Customer Satisfaction	26	47	-21
18	Production Process	43	64	-21
19	Socially	64	84	-20
20	Stringent	31	50	-19

Figure 4. The Evolution of E&S Disclosure Quantity Rankings by Country

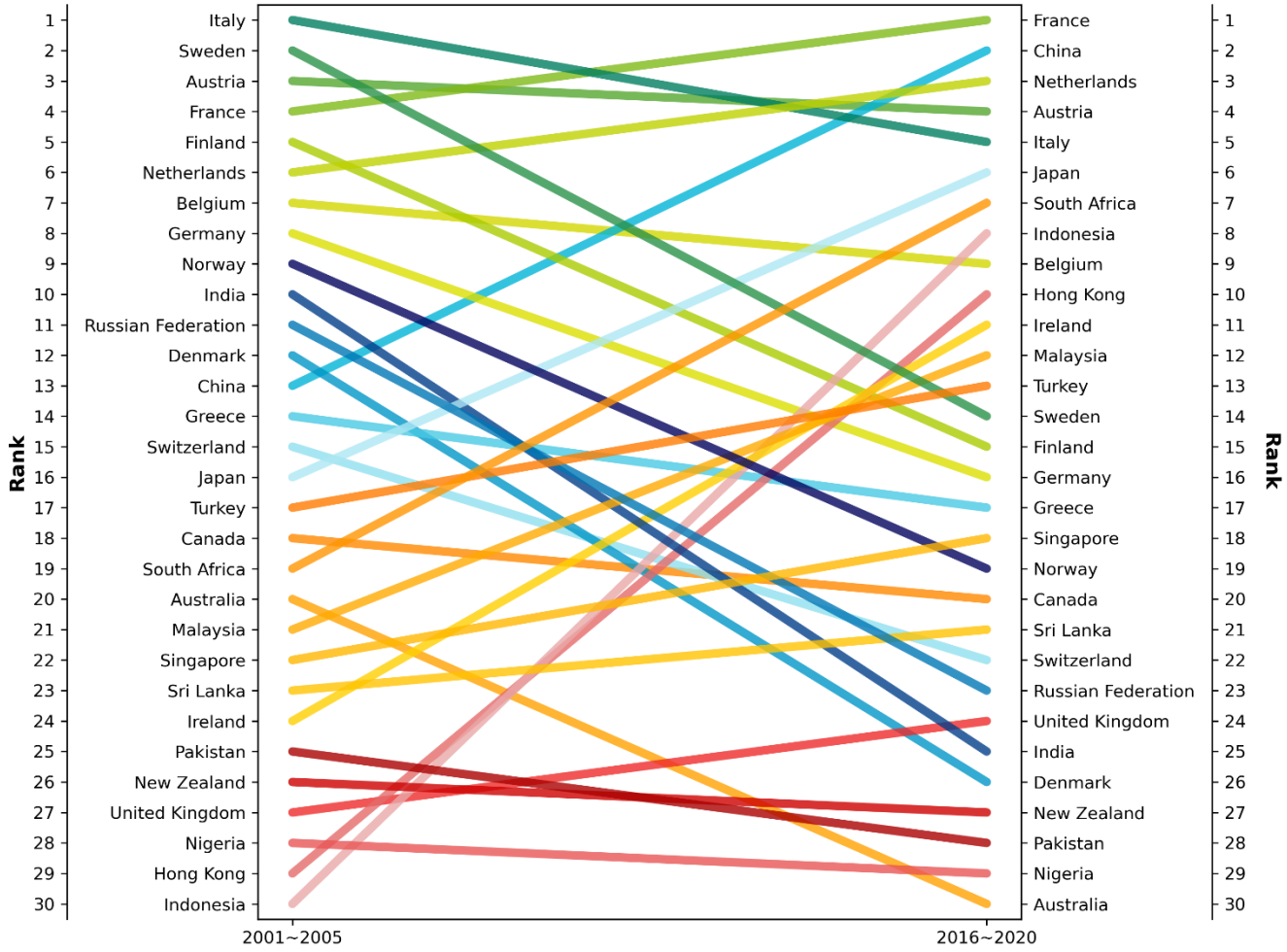


Figure 5. Percentage of Firms Adopting Voluntary ESG Reporting Frameworks by Year