

ENVIRONMENTAL, SOCIAL, AND GOVERNANCE MATERIALITY IN XBRL DISCLOSURES AND ITS PERFORMANCE PREDICTABILITY

EVIDENCE FROM JAPAN

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NO. 744

October 2024

ADB ECONOMICS
WORKING PAPER SERIES

ADB Economics Working Paper Series

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No. 744 | October 2024

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ISSN 2313-6537 (print), 2313-6545 (PDF)
Publication Stock No. WPS240467-2
DOI: <http://dx.doi.org/10.22617/WPS240467-2>

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ABSTRACT

By gathering and analyzing the textual information in eXtensible Business Reporting Language format from the annual securities reports of around 3,800 Japanese listed companies from 2013 to 2023, this study aims to uncover the trend of Japanese corporate environmental, social, and governance (ESG) materiality disclosure, particularly the environmental aspects. Furthermore, this research explores the potential of self-disclosed ESG information based on eXtensible Business Reporting Language technology as an alternative source for predicting companies' sustainability and financial performance. An upward trend in environmental information disclosure was identified, suggesting a deepening corporate commitment to sustainability practices. Second, our correlation analysis indicated that E, S, and G materialities are increasingly disclosed in a unified manner rather than in isolation. Third, our analysis found limited evidence of a relationship between self-disclosed ESG materiality and corporate financial and ESG performance, which indicates that corporates' self-disclosure of ESG materiality is not yet sufficient to use as a stand-alone measure to evaluate and predict financial profitability and climate performance.

Keywords: XBRL, ESG materiality, ESG disclosure, fixed panel regression

JEL codes: C23, M41, O16, Q56

1. Introduction

Surging environmental, social, and governance (ESG) investment drives have increased demand for more information on companies' sustainability performance. As a useful instrument for investors to obtain information, ESG ratings are crucial for measuring a company's adherence to sustainability principles. However, several limitations behind these ratings are casting a shadow on their utilization by investors and stakeholders.

First, the process and methodologies employed by various ESG rating agencies are frequently criticized for their opacity, often described as a "black box" (Berg, Koelbel, and Rigobon 2020). This lack of transparency makes it challenging for investors and companies alike to understand the criteria and weighting applied to evaluate ESG performance (Abhayawansa and Tyagi 2021, Mazzacurati 2021). The absence of a standardized approach across agencies further complicates comparisons and assessments, leading to discrepancies in ratings for the same entities (Berg, Koelbel, and Rigobon 2020; Yu 2021). Divergent ratings arouse doubts on the comparability and accuracy of ESG ratings in the market (Halper et al. 2022, European Investment Bank 2022).

The second limitation relates to the high cost of purchasing ESG ratings data. ERM (2022) found that surveyed asset managers and owners spend an average of \$487,000 annually on ESG ratings data and services. Such high costs make it difficult for the public to access.

Third, there is a pronounced bias in ESG ratings toward large corporations and entities from developed countries. This skewness is primarily due to the greater availability of ESG-related information from such entities, which often have more resources to dedicate to sustainability reporting and compliance. Consequently, smaller companies and those from emerging markets are underrepresented and, at times, unfairly penalized in ESG assessments, despite potentially making significant sustainability efforts (Cheng, Ioannou, and Serafeim 2014; European Federation of Financial Analyst Societies 2022).

Finally, the predictive value of ESG ratings in forecasting companies' financial performance has been questioned. It is argued that ESG ratings, in their current form, do not consistently predict future financial outcomes (Friede, Busch, and Bassen 2015). The variability in findings across studies highlights the challenges in using ESG ratings as a reliable predictor of financial performance, owing in part to methodological issues and biases.

The limitations inherent in current ESG rating methodologies underscore the pressing need for an alternative approach to gather corporate-sustainability-related information. One promising direction is the utilization of corporate self-disclosed information in digital format using eXtensible Business Reporting Language (XBRL), a computer language that is widely used in business reporting. The machine-readable nature of XBRL allows for the standardized electronic sharing of business, financial, and nonfinancial information in a way that improves the accessibility and comparability of the information. In the Asian context, the utilization of XBRL has been underway for a long time and is quite advanced in Japan in particular. Japan's Financial Services Agency (FSA) launched the adoption of XBRL for the electronic disclosure of documents in 2008. Listed companies are mandated to submit their financial statements in XBRL format via the FSA's

Electronic Disclosure for Investors' Network. Amid the increasing trend of ESG investment, Japanese listed companies are increasingly encouraged to disclose ESG-related information in annual securities reports. In 2023, a new section for sustainability-related information became mandatory in annual securities reports for all listed companies.

Taking Japan as a case study, this research is dedicated to elucidating the evolving dynamics of ESG information disclosure of Japanese listed companies within the framework of XBRL data, with a particular focus on the environmental aspect. This research testifies to the potential of companies' self-disclosed data in XBRL format as an alternative method to predict companies' financial and ESG performance.

In line with the overall purpose of this study, our research aims to

1. track the progression of ESG-related keywords and materiality disclosure, and explore the interconnections between E, S, and G materialities;
2. characterize the attributes of firms that actively engage in disclosing environmental-related materiality;
3. dissect the link between corporate financial performance and their environmental-related materiality; and
4. investigate the association between corporates' actual climate performance and their E, S, and G materiality disclosures.

The significance of this research lies in its illumination of ESG reporting behaviors based on rich XBRL data, focusing on the Asian context by taking Japan as a case study. Scrutinizing how Japanese companies prioritize and articulate ESG materiality, this study endeavors to expand the academic corpus while simultaneously offering pragmatic insights for corporations, investors, and regulatory bodies in other Asian countries. By utilizing XBRL data to highlight Japan's progress on corporate disclosure of ESG information, the study provides valuable insight for emerging markets, such as member states of the Association of Southeast Asian Nations (ASEAN), encouraging the adoption of similar practices to strengthen their own ESG disclosures.

This paper is organized as follows. Section 2 provides a review of the relevant literature on XBRL data reporting. Section 3 introduces the methodology, including data collection and statistical analysis, and the model utilized in this research. Section 4 discusses the results from the data analysis. Finally, section 5 concludes.

2. Literature Review: Utilization of XBRL Data in Corporate Reporting

XBRL has significantly transformed the landscape of financial reporting worldwide. By enabling the standardized electronic communication of business and financial data, XBRL enhances the transparency, efficiency, and comparability of financial information, catering to the needs of investors, regulators, and other stakeholders.

A significant merit of XBRL technology is that it sheds light on the convenience of data cleansing, as it significantly reduces the workload of data collection and preprocessing, and assures data accuracy. Computer-readable tags for report data are established following corresponding taxonomies, which are dictionaries providing digital meaning for each report concept (XBRL). Automated data gathering using XBRL tags allows investors to collect and analyze data in a more accurate and efficient manner, which benefits the research of textual information in corporate reporting (Hoitash, Hoitash, and Morris 2021).

In the United States, the Securities and Exchange Commission spearheaded the adoption of XBRL for the submission of financial statements by public companies to improve the accessibility and accuracy of financial data for investors (Securities and Exchange Commission 2009). This initiative underscores the critical role of XBRL in enhancing market transparency and investor protection. Similarly, the European Securities and Markets Authority mandated that listed companies submit their annual financial reports in XBRL format under the European Single Electronic Format initiative, facilitating the analysis and comparability of financial information across different European Union markets (European Securities and Markets Authority 2019). Mora and Mora (2012) highlighted the Spanish Accounting Association's approach to XBRL taxonomy, illustrating global efforts to harness XBRL for enhanced reporting practices.

Japan has demonstrated leadership in the adoption of XBRL, with the FSA first requiring listed companies to submit their financial statements in XBRL format in 2008. This mandate significantly improved the efficiency and transparency of financial data within the Japanese market (Financial Services Agency 2008). The proactive approach of Japan showcases the global trend toward leveraging digital reporting standards to streamline financial disclosures. Regarding ESG disclosure practices, annual securities reports—the disclosure of which is compulsory for all listed companies in Japan—convey companies' ESG information in XBRL format. It has been mandatory for listed companies in Japan to disclose sustainability information in annual securities reports since the fiscal year ending in March 2023 (Financial Services Agency 2023).

The application of XBRL extends beyond traditional financial reporting to integrated reporting, as discussed by Eccles and Krzus (2010) in their exploration of XBRL's potential in *One Report: Integrated Reporting for a Sustainable Strategy*. Furthermore, Hoffman and Mora (2013) delve into the digitization of financial reports, addressing the challenges and opportunities presented by the transition to XBRL. Utilizing XBRL in ESG and nonfinancial reporting has also been discussed in the literature (see, for example, Seele 2006; Efimova, Rozhnova, and Gorodetskaya 2019; Mousa and Ozili 2022). It is anticipated that XBRL can bring multiple positive impacts, including reducing the cost of reporting and enhancing the data transparency of ESG reporting (Faria and Mora 2017, Michael and Maciej 2012).

3. Methodology and Model

Creation of Master Materiality Framework and Keywords Dictionary for Text Mining

In the methodology of our study, the development of a keywords dictionary stands as a foundational element for the text mining process aimed at extracting ESG materiality information from corporate disclosures. This dictionary was meticulously constructed based on a master materiality framework, devised specifically for this research. The creation of this master framework involved a comprehensive synthesis of the common elements found across established ESG frameworks, alongside the incorporation of vendor-rating methodologies, thereby aiming to achieve a unified, inclusive structure that captures the full spectrum of ESG materiality concerns. In crafting this framework, significant reference was made to the Global Reporting Initiative and the Sustainability Accounting Standards Board due to their wide acceptance and relevance. Furthermore, the framework benefits from the inclusion of insights from mainstream ESG rating vendors such as MSCI, FTSE, and SandP, thereby enriching it with industry-specific viewpoints. The resulting master materiality framework, organized into 12 distinct materiality categories, reflects a careful grouping of ESG standards and ratings based on the similarity in definitions and targeted ESG issues. In total over 1,180 keywords were identified and cataloged, providing a robust basis for the subsequent text mining efforts. Specific examples of these keywords, representative of each materiality category, are detailed in **Table 1**, offering a glimpse into the comprehensive scope of our analysis.

Data Collection

Descriptive Statistics about the Investigated Listed Companies on the Tokyo Stock Exchange

This research targeted companies listed in all markets of the Tokyo Stock Exchange, including the prime market, standard market, and growth market. The number of listed companies investigated in this research, covering financial year (FY) 2013 to FY2023, are included in **Table 2**.¹

As shown in **Figure 1**, following the definition of the Asian Development Bank's *Small and Medium-Sized Enterprise Monitor 2023*, about 88.1% of companies listed on the Tokyo Stock Exchange in 2023 were categorized as large companies, while only 7.5% were categorized as small or medium-sized enterprises (SMEs). In terms of firms' growth stage (Corporate Finance Institute), 76.8% of listed Japanese companies in 2023 were categorized as mature. Meanwhile, companies in the growth or early stages comprised 23.2% of the total. Regarding industry type,

¹ In the context of this research paper, the term "financial year" refers to the accounting period used by a company for reporting its annual financial statements. Further, the financial year is defined based on the date when the company's annual securities report is released. Specifically, a financial year is assigned to the calendar year in which the accounting period falls.

following the Global Industry Classification Standard, the three largest industry sectors were industrials (26%), consumer discretionary (19%), and information technology (17%).

Text Mining and Data Preprocessing

To effectively analyze ESG disclosure trends within annual securities reports, our methodology employed text mining techniques to identify and quantify the presence of ESG-related information. This process commences with a meticulous search through the texts of these reports, specifically targeting sections that include an “overview of the business” and “information about reporting company,” as these sections are considered rich in ESG-related disclosures. We also looked through the section of the disclosure of sustainability-related financial information in all reports released in FY2023. Annual security reports in XBRL format were collected from the FSA’s Electronic Disclosure for Investors’ Network. Our analysis spans more than a decade, covering FY2013–FY2023. The core of our text mining process involves counting the frequency of occurrences for each keyword from our developed ESG keywords dictionary.

To construct a robust profile of ESG materiality disclosure, we further aggregated the keyword occurrences related to each of the 12 materiality categories annually. This approach not only quantifies the presence of ESG materiality within corporate disclosures but also offers insights into the emphasis placed on different ESG dimensions over time, reflecting the dynamic nature of corporate sustainability priorities.

Proxy Measures of the Financial and Climate Performance of Targeted Companies

Our study selects specific indicators to assess the relationship of ESG materiality disclosure on financial and climate performance. Financially, we focus on return on equity, measuring profitability relative to shareholder investment; return on assets, indicating operational efficiency; and Altman’s Z-score, measuring a company’s bankruptcy risk. For climate-related performance, we examine greenhouse gas (GHG) emissions relative to sales and assets, providing insights into environmental impact per economic activity and resource utilization. Two indicators, total GHG emissions per sales and total GHG emissions per asset were selected as measurements.

These chosen indicators enable a comprehensive evaluation of how ESG disclosures correlate with both the financial health and environmental stewardship of listed companies, offering a multi-faceted view of corporate sustainability.

Financial data are also collected and calculated from the annual securities reports. Meanwhile, GHG emissions data are collected separately from other official documents such as integrated reports and sustainability reports.

Statistical Analysis and Modeling

A comprehensive statistical analysis and modeling approach was employed to dissect the nuances of ESG materiality disclosure and its impact on corporate financial and ESG performance.

We further engaged in correlation analysis to explore the interrelations among the 12 ESG materialities to address our first objective: to track the progression of ESG-related keywords and materiality disclosure, and explore the interconnections between E,S, and G materialities. This step is crucial for uncovering potential synergies or divergences within the broad spectrum of ESG disclosures.

To address our second objective—to characterize the attributes of firms that actively engage in disclosing environmental-related materiality—logistic regression was deployed to elucidate the characteristics of companies inclined toward ESG materiality disclosure, as this model is suitable for cases in which the dependent variable has a binary value. This analysis scrutinizes company size, industry sector, and the presence of disclosure across 12 materiality categories through dummy variables, with specific variables detailed in **Table 3**.

As explained in the previous section, the third objective is to dissect the link between corporates' financial performance and their environmental-related materiality; and the fourth objective is to investigate the association between corporates' actual climate performance and their E, S, and G materiality disclosures. For achieving the third and fourth objectives, our analysis leverages the fixed-effects panel regression model, a method particularly suited for panel-data analysis. We selected fixed-effects panel regression because this model excels in exploring the impact of independent variables that evolve over time on a given dependent variable, explicitly accounting for individual heterogeneity by allowing intercepts to vary across entities. Crucially, it omits time-invariant characteristics to focus solely on temporal dynamics. Within this framework, the 12 materiality disclosure dummies are positioned as independent variables, probing their influence on proxies of financial and climate-related performance, as previously delineated. The fixed-effects panel regression model can be formally expressed as follows:

$$Y_{it} = \alpha_i + \beta X_{it} + \gamma Z_{it} + \epsilon_{it}$$

Where Y_{it} represents the dependent variable (financial or climate-related performance) for entity i at time t , α_i is the entity-specific intercept capturing unobserved heterogeneity, X_{it} encompasses the 12 materiality disclosure dummies, and Z_{it} includes other time-varying covariates such as company size and industry sector. β and γ are the coefficients to be estimated, and ϵ_{it} is the error term.

In the context of this analysis, the independent variables are the 12 materiality disclosure dummies, each examined for its individual contribution to the models. Additionally, we incorporate the logarithm of total assets as a control variable to account for company size, acknowledging its potential influence on the outcomes. To further refine our understanding, we introduce interacted variables—formed by multiplying the logarithm of total assets with each materiality disclosure dummy—to probe the nuanced effects of the interaction between company size and materiality disclosure on the dependent outcomes. The details of variables for this analysis are elaborated in **Table 4**. Outliers from the data were detected and excluded from the analysis on achieving the third and fourth objectives.

4. Results and Discussion

Trend of Disclosed Keywords and Materiality across Years

Table 5 elaborates the results from the trend analysis of the top five ESG keywords from 2013 to 2023. A palpable shift is revealed in the thematic focus of corporate disclosures within the Japanese context. Initially dominated by “raw materials” in 2013, the prominence of “natural disasters” from 2014 to 2021 underscores a heightened corporate awareness and response to environmental risks, likely reflecting Japan’s vulnerability to such events. A steady ascension in the frequency of “recycling” and “production base” suggests an increasing corporate commitment to sustainable production and waste management, pointing toward the embrace of circular economy principles.

In the latter years of the review period, the surge in mentions of “climate change” signals a strategic pivot toward addressing the overarching impacts of global warming on business operations and supply chains. Furthermore, the rise of “renewable energy” and “carbon neutral” as leading topics in recent years echoes the global momentum toward sustainable energy solutions and carbon neutrality commitments. This progression in keyword prevalence denotes a significant realignment in corporate priorities, from immediate risk mitigation to long-term sustainability strategies, highlighting an evolution in ESG concerns that mirrors the global trajectory toward comprehensive environmental stewardship.

At the materiality level, we identified an increasing trend in terms of companies’ ESG information disclosure. **Figure 2** demonstrates a pronounced upward trajectory in the ratio of companies disclosing environmental materiality, with key materiality, E, exhibiting a particularly robust ascent from approximately 40% in 2013 to over 80% by 2023. This twofold increase underscores a heightened corporate commitment to environmental transparency. Climate and energy management disclosures followed suit, growing steadily from just under 40% to roughly 60% over the same period, indicating a burgeoning recognition of the financial and ethical implications of climate change on business operations.

In comparison, ecological business practices disclosure experienced a more modest rise during the review period, from about 20% to slightly over 30%, suggesting a gradual integration of ecological considerations into corporate strategy. Similarly, the ratio of companies reporting on pollution and waste management ascended from around 20% to about 30%. While this represents a 50% increase, it is still relatively restrained compared to other categories, perhaps reflecting a more complex regulatory environment or differing industry standards. These quantifiable shifts reflect a dynamic environment where businesses are increasingly expected to align with sustainable practices, driven by evolving regulatory frameworks, investor demands, and a global impetus toward mitigating climate-related risks.

Correlation of Frequency of E, S, and G Materiality Occurrence

The correlation analysis within and between the ESG aspects presents an intricate web of interrelations among the 12 materiality topics (**Figure 3**). Key findings within the environmental

aspect reveal a moderate to strong positive correlation that is particularly evident in the association between “climate and energy management” and “pollution and waste management” ($r = 0.53$). This notable interconnection signifies that attention to one area of environmental concern is often paralleled by awareness in other related areas.

Regarding the correlations between environmental and social aspects, significant links are illustrated by the substantial correlation of “climate and energy management” with “community engagement and human rights” ($r = 0.52$) and “human capital and labor rights” ($r = 0.62$). A similar result is also noted between “pollution and waste management” and “human capital and labor rights” ($r = 0.51$). This finding suggests a strategic alignment in addressing environmental challenges while concurrently engaging with diverse social issues, reflecting a holistic view of corporate social responsibility.

A meaningful relationship is also present in the result between the environmental aspect and governance aspect. The correlation between “climate and energy management” and “corporate governance and accountability” ($r = 0.48$) reinforces the key message that environmental management practices are increasingly being integrated into the fabric of corporate governance. While the correlation is moderate, it indicates a growing recognition of the importance of governance structures in supporting environmental strategies.

A compelling narrative on the convergence of E, S, and G materialities over recent years is also observed in the analysis. In line with Figure 3, **Figure 4** highlights how the correlations between “corporate governance and accountability” and “climate and energy management” and “pollution and waste management” increased over the review period. The trend highlights a shift toward integrated ESG governance, where the impact of a company's environmental policies is directly influenced by—and perhaps even contingent upon—its governance and accountability practices. Concurrently, the correlation between “community engagement and human rights” and environmental aspects reflect a growing corporate awareness of the social dimensions of environmental responsibility. Additionally, the rising correlation between “human capital and labor rights” and “climate and energy management” indicate that companies are increasingly mindful of the human aspects intertwined with environmental strategies.

These trends do not merely depict a reactive alignment but signal a proactive, holistic approach to ESG where the boundaries between environmental, social, and governance concerns are becoming more fluid and integrated into the core fabric of corporate operations and reporting.

Features of Companies Disclosing Environmental Materiality

In the landscape of ESG disclosures, findings from regression analysis illuminate a pronounced inclination among certain sectors toward reporting on environmental materiality (**Table 6**). Specifically, the energy, materials, consumer staples, and utilities sectors exhibit a statistically significant tendency to disclose information pertaining to “climate and energy management,” with coefficients indicating a strong likelihood of reporting. These sectors, vital to the environmental narrative due to their direct impact on ecological systems, demonstrate an acute awareness of

their role in climate-related issues, reflecting an intrinsic link between their operational practices and sustainability commitments.

Furthermore, similar results on pollution and waste management from the aforementioned sectors are revealing an industry-specific focus on managing the environmental implications of material sourcing and processing. This significant reporting behavior aligns with the heightened environmental responsibilities that these manufacturing-related sectors face and their critical influence on the sustainable management of natural resources.

In terms of company size, SMEs tend to be less likely to disclose environmental materiality than large companies. Meanwhile, multinational companies tend to be more likely to disclose environmental materiality. SMEs may be less likely to disclose environmental materiality compared to larger firms due to resource constraints that limit their ability to invest in sustainability initiatives and reporting infrastructure. They may also face less regulatory pressure and public scrutiny than their larger counterparts. On the other hand, multinational or global companies often have more resources and are subject to international regulatory standards and consumer expectations, which drive them to adopt more transparent and comprehensive environmental disclosure practices.

Compared with companies in the growth stage, those in the early stage tend to be less likely to disclose environmental materiality. Meanwhile, those in the mature stage are more likely to disclose environmental materiality. Those in the early stage of development may prioritize immediate business viability and scaling operations over the complexities of extensive ESG reporting. They might not yet have the structures in place to systematically track and report on environmental materiality. In contrast, companies in the growth stage, having established more stability, may start to integrate and disclose environmental practices as part of their expanding operational and strategic planning, aligning with investor expectations and long-term sustainability goals.

Relationship between Companies' Materiality Disclosure and their Financial and Climate-Related Performance

In examining the dynamic interplay between ESG disclosures and financial performance, our fixed-effects panel regression analysis yielded salient insights. A pivotal finding emerges from the relationship between climate and energy management (CEM) disclosures and corporate risk bankruptcy, as proxied by Altman's Z-score. The statistically significant parameter estimates (CEM: parameter = 0.323, $p < 0.001$; CEM * coefficient size: parameter = 0.023, $p < 0.001$) underscore a robust positive impact (**Table 7**), suggesting that proactive CEM disclosure is perceived as a hallmark of financial robustness, particularly when accounting for firm size. This aligns with the argument that contemplates ESG transparency as a catalyst for lower perceived risk and enhanced investor confidence (Kim and Yasuda 2018).

Furthermore, the interaction term's significance suggests that larger firms are likely to experience a magnified positive effect of CEM disclosure on financial stability, potentially due to more comprehensive CEM strategies or greater stakeholder scrutiny. These findings contribute to the

discourse on the materiality of ESG practices, supporting assertions from previous research which posits that ESG disclosures, specifically those related to environmental stewardship, can serve as risk mitigants and indicators of long-term sustainability.

Our panel regression analyses yield insightful distinctions into how ESG disclosures relate to GHG emissions, measured against both company assets and sales, revealing nuanced implications of company size. Strategic risk management stands out with a notable negative coefficient when interacted with company size for both GHG emissions per asset (parameter = -0.004 , $p = 0.000$) and per sales (parameter = -0.003 , $p = 0.004$) (**Table 8**), implying that larger firms realize more substantial emission reductions in relation to their size when they effectively engage in strategic risk management. The finding implies that larger organizations can leverage their scale and resource base to implement more robust environmental risk mitigation strategies. Furthermore, the interaction of corporate governance and accountability with company size in the emissions per sales model (parameter = -0.079 , $p = 0.001$) and the emissions per asset model (parameter = -0.112 , $p = 0.000$) indicates that larger firms with robust governance structures have a pronounced ability to manage their emissions efficiency.

On the contrary, companies that disclosed pollution and waste management (parameter = 0.049 , $p=0.001$) and nature resource stewardship (parameter = 0.022 , $p=0.023$) tend to have higher GHG emissions per asset. Furthermore, the positive coefficients for natural resource stewardship * company size (parameter = 0.001 , $p = 0.043$) and pollution and waste management * company size (parameter = 0.003 , $p = 0.012$) in emissions per asset suggest that the benefits of disclosures in these areas diminish as firms grow larger. This may point to operational or industry-specific challenges that larger firms face, which could offset the advantages of their scale.

5. Conclusion

Using the text data disclosed in XBRL format, this study encapsulates a series of enlightening revelations on ESG materiality disclosure trends and their implications for corporate reporting practices in the Japanese market. An increasing trend of ESG disclosures was observed by utilizing the advanced capabilities of XBRL technology to extract data from annual securities reports. This upsurge in reporting frequency not only quantifies the expanding scope of corporate transparency but also underscores the accelerating integration of ESG considerations into business communication.

Our study confirms that ESG disclosures are not isolated incidents but rather are interlinked, revealing a corporate shift toward addressing ESG issues in a holistic manner. This comprehensive approach to ESG materiality suggests that companies are moving beyond the siloed treatment of environmental, social, and governance factors to embrace a more interconnected view of ESG issues. The tendency to report on ESG as a cohesive framework reflects a maturation in corporate ESG narratives and underscores the evolving complexity of sustainability challenges faced by today's businesses.

However, despite several identified correlations and statistically significant relationships, we argue that companies' self-disclosure of ESG materiality alone proved insufficient as a stand-alone measure to evaluate and predict corporates' financial and climate performance. This finding calls into question the usefulness of current disclosure practices and suggests a potential disconnect between reported ESG materiality and actual financial and environmental outcomes.

In conclusion, while the rising trend in ESG disclosures points to a heightened corporate commitment to transparency, there remains a critical need for enhanced reporting frameworks and methodologies that can more accurately reflect and predict a company's sustainability trajectory. As ESG concerns become increasingly integrated into the mainstream business agenda, the demand for more insightful, predictive, and comprehensive disclosure practices will inevitably grow, guiding stakeholders in making more informed decisions and fostering a more sustainable corporate ecosystem.

This research offers evidence-based insights for corporations, investors, and regulatory bodies in emerging markets in ASEAN countries on the importance of understanding the informativeness of current ESG disclosure practices, as well as the necessity to explore comparable and cost-efficient ways besides self-disclosed ESG data to gather corporate ESG performance-related information and enhance transparency in ESG finance markets. As for the policy implications, this research recommends that ASEAN's increasingly integrated financial markets adopt XBRL technology in corporate ESG information disclosure. The usefulness of XBRL data in better understanding corporate ESG performance is proven in this research, shedding light on how to accelerate ESG disclosure in ASEAN financial markets. We believe that promoting the adoption of XBRL technology will be beneficial to accelerating the development of ESG information disclosure in emerging financial markets.

TABLES AND FIGURES

Table 1: List of Key Materiality with Keyword Examples

ESG	Materiality	Keywords
E	Climate and Energy Management	CO ₂ emissions, carbon neutral, solar energy, clean energy, climate change
	Pollution and Waste Management	Pollution, air quality, abnormal weather, waste management, water disposal
	Natural Resource Stewardship	Procurement, material procurement, biodiversity, biodegradable plastic, forest management
	Ecological Business Practices	Circular economy, ecosystem, ecology, smart agriculture, green procurement
S	Community Engagement and Human Rights	Human rights, diverse workforce, discrimination, employee engagement, child labor
	Human Capital and Labor Rights	Labor cost, human capital, labor disaster, labor efficacy, mental health
	Customer and Digital Responsibilities	Information security, supply chain, Internet of Things, consumer protection, product quality
	Access, Inclusivity, and Social Welfare	Diversity, social responsibility, health coverage, medical insurance, foreign labors
G	Corporate Governance and Accountability	Board, general meeting of stakeholder, corporate governance, executive compensation, accounting standard
	Corporate Ethics and Compliance	Corporate ethics, compliance, supervisory function, ethical breach, internal control
	Strategic Risk Management	BCP, business continuity, cyber security, digital strategy
	Transparency and Stakeholder Engagement	Financial reporting, transparency, institutional investor, integrated reporting, audit committee, audit reporting

BCP = business continuity planning, CO₂ = carbon dioxide.

Source: Authors.

**Table 2: Number of Listed Companies on the Tokyo Stock Exchange
by Financial Year**

Financial year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of companies	3,135	3,210	3,325	3,402	3,512	3,625	3,717	3,773	3,794	3,796	3,266

Source: Authors' calculations.

Table 3: Explanation of Variables Utilized in the Logistics Regression Model

Type of Variable	Variable	Explanation
Dependent variable (Y)	4 environmental materiality disclosure dummies	Whether ESG information disclosed for a certain materiality in annual securities reports; dummy = 1 if any keywords of the materiality are disclosed
Independent variable (X)	3 size dummies	SMEs, large (baseline group), global (ADB's <i>Small and Medium-Sized Monitor</i> definition with modification); dummy = 1 if belongs to the group
	11 sector dummies	11 sectors (Global Industry Classification Standard); dummy = 1 if belongs to the group; baseline group: industrials (reason: the largest group among all sectors)
	3 company stage dummies	Early, growing (baseline group), mature (Corporate Finance Institute's definition)
Control variable (ϵ)	11 fiscal years dummies	FY2013–FY2023

ADB = Asian Development Bank; ESG = environmental, social, and governance; FY = financial year.
Source: Authors.

Table 4: Explanation of Variables in the Fixed-Effects Panel Regression Analysis

Type of Variable	Variable	Explanation
Dependent variable (Y)	ROA	Return on asset, an indicator measuring a company's profitability
	ROE	Return on equity, an indicator measuring a company's operating efficiency
	Altman's Z-score	A representative indicator measuring a company's bankruptcy
	GHG emissions per sales	Amount of GHG emissions divided by total revenues
	GHG emissions per asset	Amount of GHG emissions divided by total assets
Independent variable (X)	12 materiality disclosure dummies	12 materialities from the master materiality framework; dummy = 1 if belongs to the group
	12 materiality disclosure dummy x company size (log)	(control variable: company size, log[company total asset] as proxy)
Fixed effect	Financial year, Other time-invariant variables (e.g., sector)	

GHG = greenhouse gas.

Source: Authors' compilation.

Table 5: Total Number of Top-Ranked Environmental Keywords, FY2013–FY2023

Financial Year	Top 1		Top 2		Top 3		Top 4		Top 5	
	Keyword	FO	Keyword	FO	Keyword	FO	Keyword	FO	Keyword	FO
2013	Raw Materials	269	Natural Disasters	267	Production Base	46	Recycling	30	Water Quality	28
2014	Natural Disasters	3,121	Raw Materials	3,009	Production Base	662	Recycling	512	Energy Conservation	328
2015	Natural Disasters	3,326	Raw Materials	3,120	Production Base	672	Recycling	510	Energy Conservation	319
2016	Natural Disasters	3,655	Raw Materials	3,198	Production Base	676	Recycling	514	Energy Conservation	304
2017	Natural Disasters	3,971	Raw Materials	3,588	Production Base	959	Recycling	685	Renewable Energy	473
2018	Natural Disasters	4,504	Raw Materials	3,939	Production Base	1,000	Recycling	820	Renewable Energy	572
2019	Natural Disasters	4,953	Raw Materials	4,083	Production Base	1,016	Recycling	905	Renewable Energy	649
2020	Natural Disasters	7,324	Raw Materials	6,209	Supply Chain	1,928	Production Base	1,516	Recycling	1,333
2021	Natural Disasters	7,220	Raw Materials	6,868	Climate Change	2,479	Supply Chain	2,404	Renewable Energy	1,667
2022	Raw Materials	11,447	Natural Disasters	7,742	Climate Change	6,006	Supply Chain	4,218	Carbon Neutral	2,256
2023	Climate Change	15,515	Raw Materials	10,888	Natural Disasters	6,811	Supply Chain	4,706	Carbon Neutral	3,986

FO = frequency of occurrence, FY = financial year.

Source: Authors' calculations based on annual securities reports from over 3,800 listed companies in Japan.

Table 6: Results of Logistics Regression on the Likelihood of Companies' Environmental Materiality Disclosure

Independent Variable	CEM			PWM			NRS			EBP		
	Coef.	SD	P-Value	Coef.	SD	P-Value	Coef.	SD	P-Value	Coef.	SD	P-Value
Constant	0.923	0.056	0.000	0.868	0.055	0.000	-1.359	0.065	0.000	-2.218	0.072	0.000
Sector 10: Energy	1.515	0.290	0.000	0.537	0.183	0.003	0.111	0.156	0.478	0.088	0.184	0.634
Sector 15: Materials	0.337	0.058	0.000	1.786	0.082	0.000	0.534	0.048	0.000	0.683	0.055	0.000
Sector 25: Consumer Discretionary	0.020	0.041	0.618	-0.280	0.037	0.000	-1.072	0.049	0.000	-0.050	0.047	0.290
Sector 30: Consumer Staples	0.227	0.058	0.000	0.624	0.058	0.000	-0.272	0.057	0.000	1.110	0.054	0.000
Sector 35: Health Care	0.321	0.065	0.000	-0.437	0.061	0.000	-0.650	0.081	0.000	0.516	0.073	0.000
Sector 40: Financials	0.152	0.069	0.027	-2.091	0.066	0.000	-1.501	0.103	0.000	0.560	0.071	0.000
Sector 45: Information Technology	0.020	0.044	0.639	-0.632	0.039	0.000	-0.663	0.049	0.000	-0.339	0.055	0.000
Sector 50: Communication Services	0.174	0.064	0.007	-2.195	0.061	0.000	-1.615	0.100	0.000	-1.061	0.099	0.000
Sector 55: Utilities	2.579	0.416	0.000	0.639	0.165	0.000	-0.407	0.148	0.006	-0.168	0.164	0.308
Sector 60: Real Estates	0.646	0.079	0.000	-1.164	0.077	0.000	-1.365	0.133	0.000	0.076	0.102	0.453
Financial Year 2013	0.302	0.141	0.032	-0.413	0.142	0.004	-0.055	0.196	0.779	0.074	0.214	0.728
Financial Year 2014	0.398	0.056	0.000	-0.323	0.056	0.000	-0.292	0.078	0.000	-0.402	0.089	0.000
Financial Year 2015	0.342	0.056	0.000	-0.323	0.056	0.000	-0.278	0.077	0.000	-0.392	0.088	0.000
Financial Year 2016	0.258	0.056	0.000	-0.342	0.055	0.000	-0.299	0.077	0.000	-0.398	0.087	0.000
Financial Year 2017	0.117	0.056	0.038	-0.051	0.055	0.361	-0.089	0.074	0.229	-0.072	0.081	0.373
Financial Year 2019	0.109	0.057	0.056	-0.015	0.055	0.781	-0.016	0.072	0.820	0.150	0.077	0.052
Financial Year 2020	0.859	0.064	0.000	0.442	0.056	0.000	0.323	0.068	0.000	0.584	0.072	0.000
Financial Year 2021	0.862	0.063	0.000	0.526	0.056	0.000	0.433	0.067	0.000	0.918	0.070	0.000
Financial Year 2022	1.128	0.067	0.000	1.324	0.061	0.000	0.577	0.066	0.000	1.302	0.068	0.000
Financial Year 2023	1.941	0.096	0.000	1.957	0.076	0.000	1.170	0.066	0.000	2.036	0.069	0.000
Size: SME	0.258	0.058	0.000	-0.962	0.056	0.000	-0.721	0.098	0.000	-0.567	0.089	0.000
Size: Multinational or Global	2.038	0.154	0.000	1.421	0.092	0.000	1.358	0.064	0.000	1.369	0.065	0.000
Stage: Early	0.120	0.059	0.042	-0.327	0.056	0.000	-0.198	0.079	0.012	-0.195	0.073	0.008
Stage: Mature	0.084	0.039	0.032	-0.136	0.038	0.000	-0.051	0.043	0.228	-0.080	0.043	0.066

CEM = climate and energy management, EBP = ecological business practices, NRS = natural resource stewardship, PWM = pollution and waste management, SD = standard deviation.

Source: Authors' calculations based on annual securities reports from over 3,800 listed companies in Japan.

Table 7: Results of Fixed-Effects Panel Regression on the Relationship between Corporate Environmental Materiality Disclosure and Financial Performance

Independent Variable	ROA			ROE			Z-Score		
	Parameter	P-Value	R-squared	Parameter	P-Value	R-squared	Parameter	P-Value	R-squared
CEM*Co. size	0.016	0.258	0.000	0.001	0.941	0.000	0.023	0.000	0.001
CEM	0.080	0.617	0.006	0.005	0.982	0.002	0.323	0.000	0.006
Co. size	1.861	0.000	0.006	1.434	0.000	0.002	-0.709	0.000	0.006
PWM*Co. size	0.010	0.438	0.000	0.004	0.828	0.000	0.000	0.946	0.000
PWM	-0.019	0.896	0.006	-0.053	0.790	0.002	-0.010	0.873	0.005
Co. size	1.860	0.000	0.006	1.435	0.000	0.002	-0.715	0.000	0.005
NRS*Co. size	0.005	0.654	0.000	0.004	0.818	0.000	-0.003	0.508	0.000
NRS	0.046	0.755	0.006	0.101	0.615	0.002	-0.029	0.656	0.005
Co. size	1.860	0.000	0.006	1.435	0.000	0.002	-0.716	0.000	0.005
EBP*Co. size	0.006	0.603	0.000	-0.018	0.235	0.000	-0.001	0.899	0.000
EBP	0.062	0.656	0.006	-0.174	0.358	0.002	-0.017	0.782	0.005
Co. size	1.863	0.000	0.006	1.421	0.000	0.002	-0.717	0.000	0.005

CEM = climate and energy management, Co. = corporate (log [total asset]), EBP = ecological business practices, NRS = natural resource stewardship, PWM = pollution and waste management, ROA = return on asset, ROE = return on equity.

Source: Authors' calculations based on annual securities reports from over 3,800 listed companies in Japan.

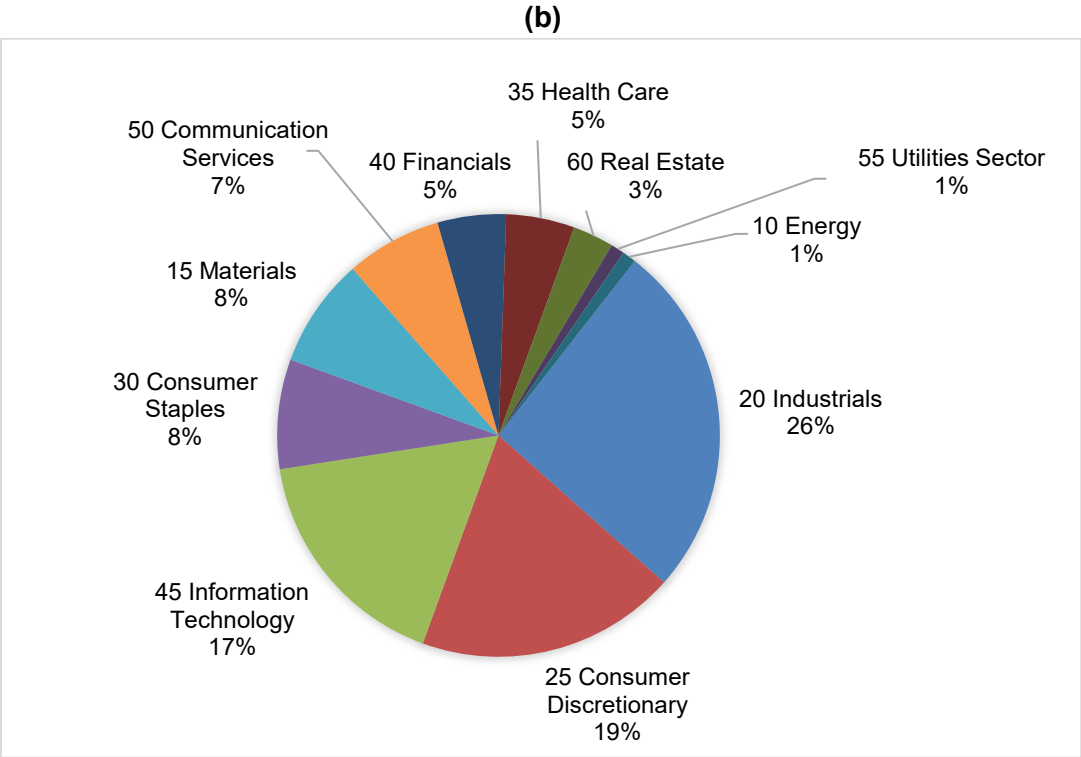
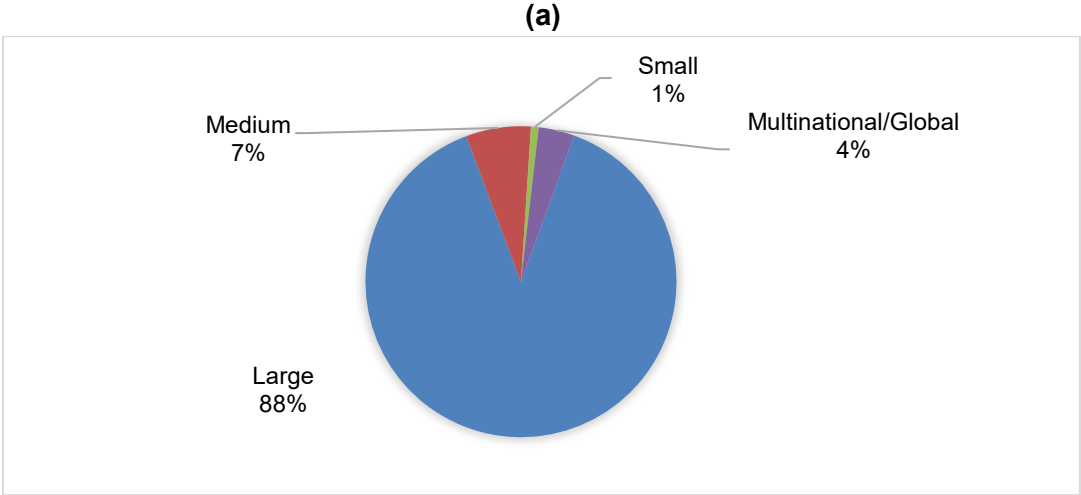
Table 8: Results from Fixed-Effects Panel Regression on the Relationship between Corporate ESG Materiality Disclosure and GHG Emissions Performance

Independent Variable	Total GHG Emissions per Sales			Total GHG Emissions per Asset		
	Parameter	P-Value	R-squared	Parameter	P-Value	R-squared
E CEM*Co. size	0.000	0.856	0.000	0.002	0.187	0.000
CEM	0.008	0.700	0.005	0.027	0.074	0.023
Co. size	-0.168	0.000	0.005	-0.243	0.000	0.023
PWM*Co. size	0.002	0.141	0.000	0.003	0.012	0.001
PWM	0.035	0.083	0.006	0.049	0.001	0.024
Co. size	-0.170	0.000	0.006	-0.246	0.000	0.024
NRS*Co. size	0.000	0.751	0.000	0.001	0.043	0.001
NRS	0.007	0.613	0.005	0.022	0.023	0.023
Co. size	-0.168	0.000	0.005	-0.245	0.000	0.023
EBP*Co. size	-0.001	0.516	0.000	-0.001	0.148	0.000
EBP	-0.005	0.697	0.005	-0.011	0.244	0.022
Co. size	-0.167	0.000	0.005	-0.243	0.000	0.022
S CEHR*Co. size	-0.001	0.549	0.000	0.000	0.639	0.000
CEHR	-0.008	0.540	0.005	-0.003	0.765	0.022
Co. size	-0.168	0.000	0.005	-0.243	0.000	0.022
HCLR*Co. size	0.002	0.394	0.000	0.001	0.683	0.000
HCLR	0.039	0.139	0.005	0.023	0.202	0.022
Co. size	-0.168	0.000	0.005	-0.244	0.000	0.022
CDR*Co. size	-0.003	0.140	0.000	-0.003	0.095	0.001
CDR	-0.039	0.144	0.005	-0.032	0.085	0.022
Co. size	-0.171	0.000	0.005	-0.246	0.000	0.022
AISW*Co. size	0.000	0.976	0.000	0.000	0.542	0.000
AISW	0.003	0.840	0.005	0.008	0.373	0.022
Co. size	-0.168	0.000	0.005	-0.244	0.000	0.022
G CGA*Co. size	-0.079	0.001	0.002	-0.112	0.000	0.010
CGA	-0.025	0.945	0.005	0.024	0.924	0.022
Co. size	-0.168	0.000	0.005	-0.243	0.000	0.022
CEC*Co. size	0.001	0.256	0.000	0.000	0.786	0.000
CEC	0.019	0.240	0.005	0.000	0.987	0.022
Co. size	-0.167	0.000	0.005	-0.243	0.000	0.022
SRM*Co. size	-0.003	0.004	0.002	-0.004	0.000	0.005
SRM	-0.039	0.015	0.006	-0.051	0.000	0.026
Co. size	-0.168	0.000	0.006	-0.244	0.000	0.026
TSE*Co. size	0.001	0.649	0.000	-0.003	0.162	0.000
TSE	0.029	0.422	0.005	-0.023	0.416	0.022
Co. size	-0.168	0.000	0.005	-0.244	0.000	0.022

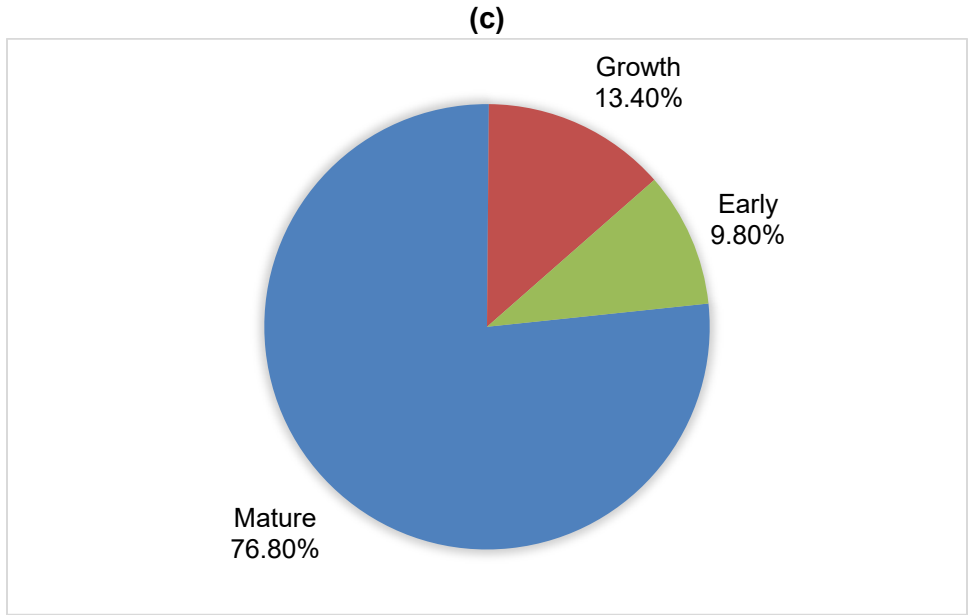
AISW = access inclusivity and social welfare; CEC = corporate ethics and compliance; CEHR = community engagement and human rights; CDR = customer and digital responsibility; CEM = climate and energy management; CGA = corporate governance and accountability; EBP = ecological business practices; ESG = environmental, social, and governance; GHG = greenhouse gas; HCLR = human capital and labor rights; NRS = natural resource stewardship; PWM = pollution and waste management; SRM = strategic risk management; TSE = transparency and stakeholder engagement.

Source: Authors' calculations based on annual securities reports from over 3,800 listed companies in Japan.

Figure 1: Shares of Listed Companies on the Tokyo Stock Exchange in FY2023 by Size (a), Sector (b), and Growth Stage (c).

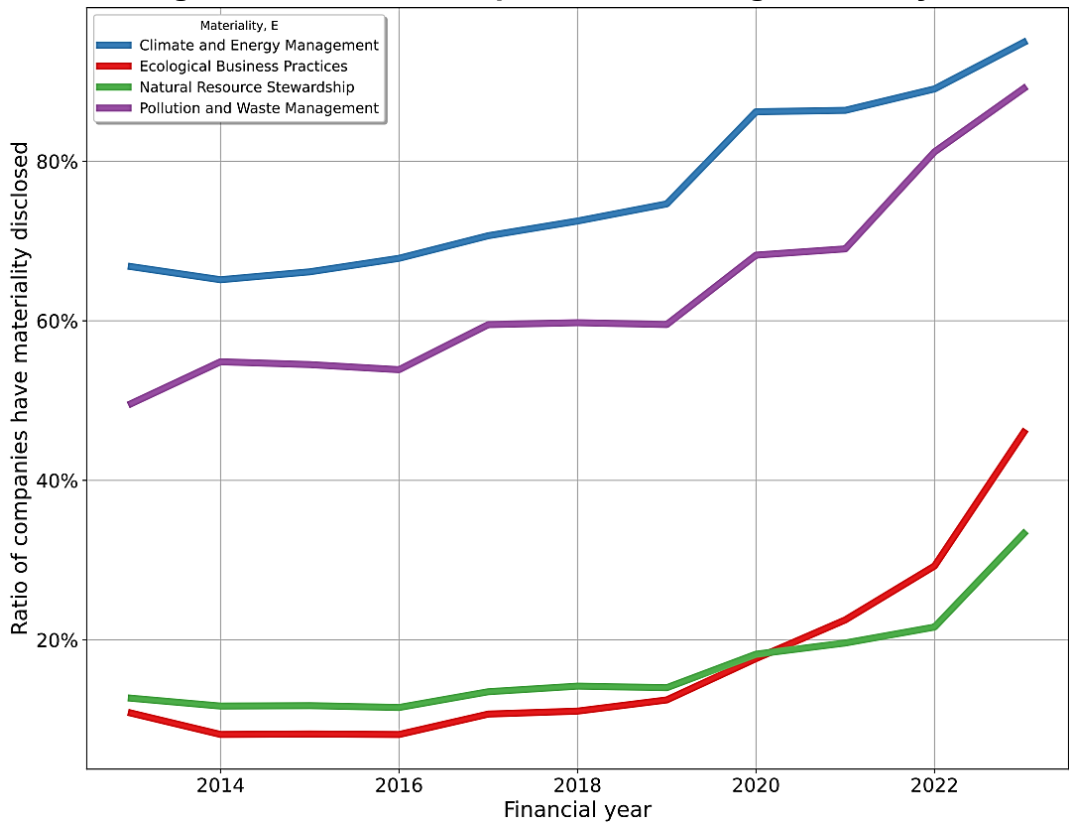


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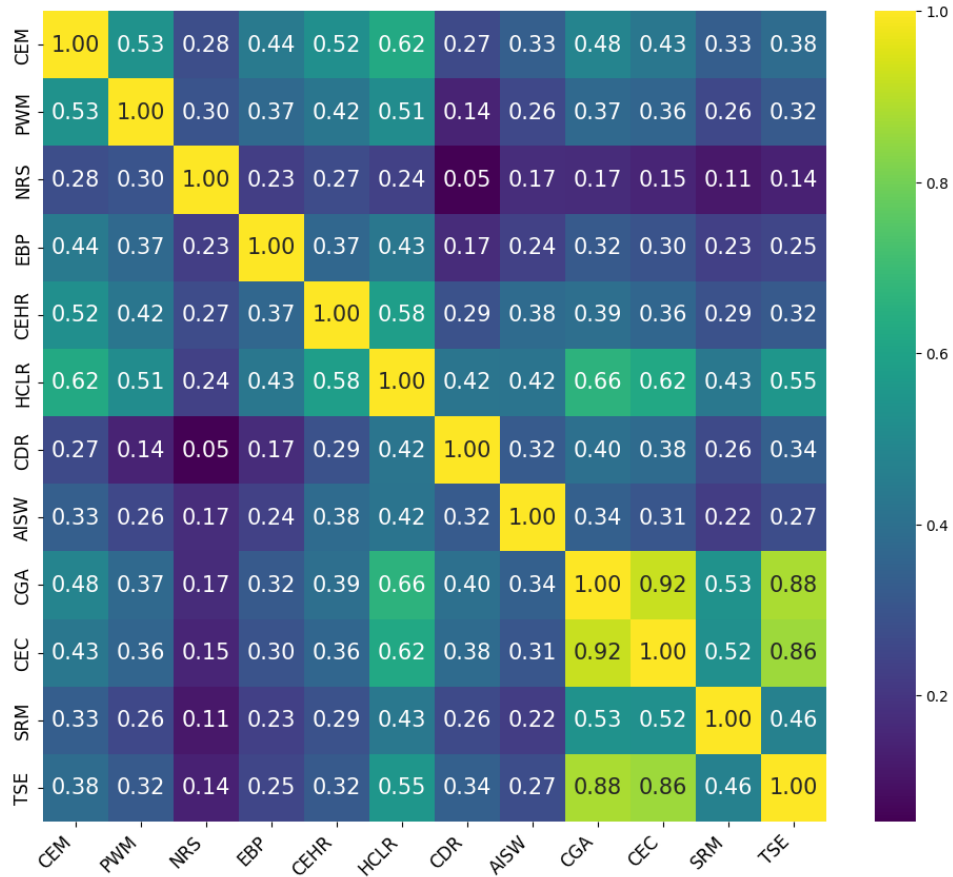
FY = financial year.
 Source: Authors' calculations.

Figure 2: Trend of Companies Disclosing Materiality



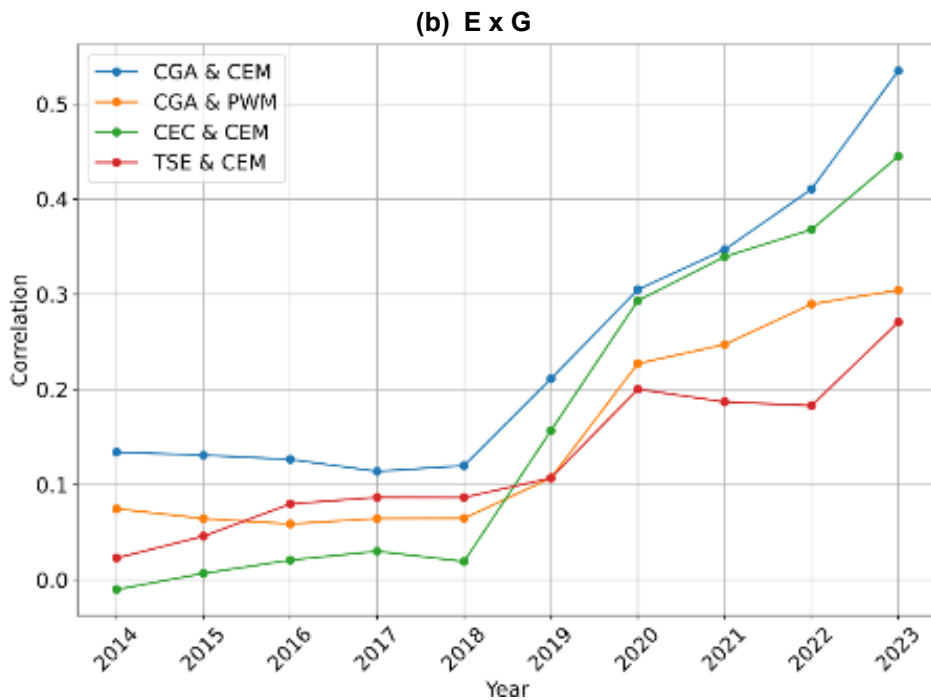
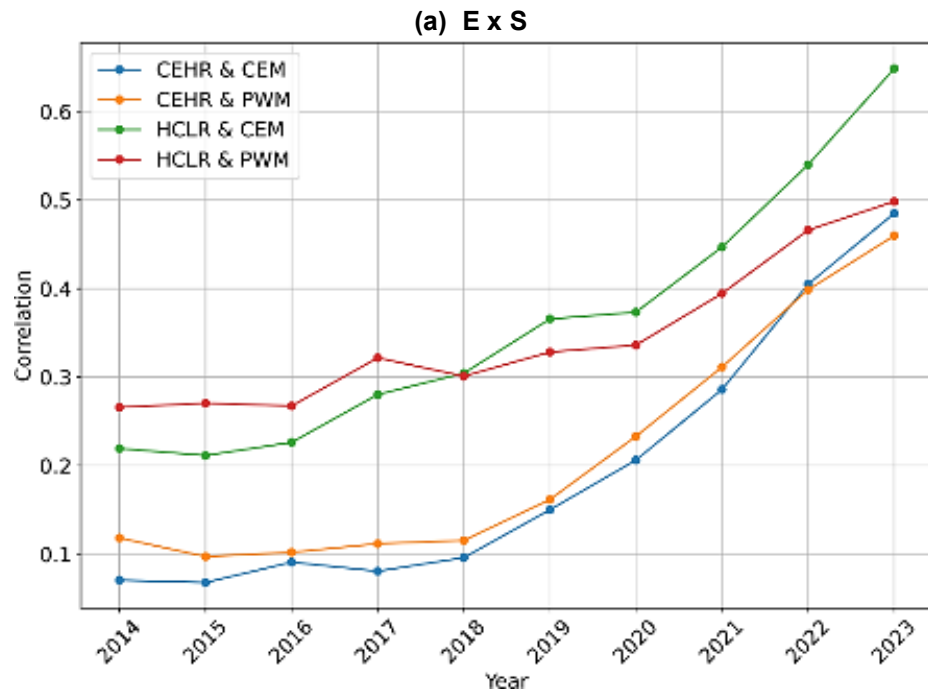
Source: Authors' calculations.

Figure 3: Correlation Among ESG Materiality



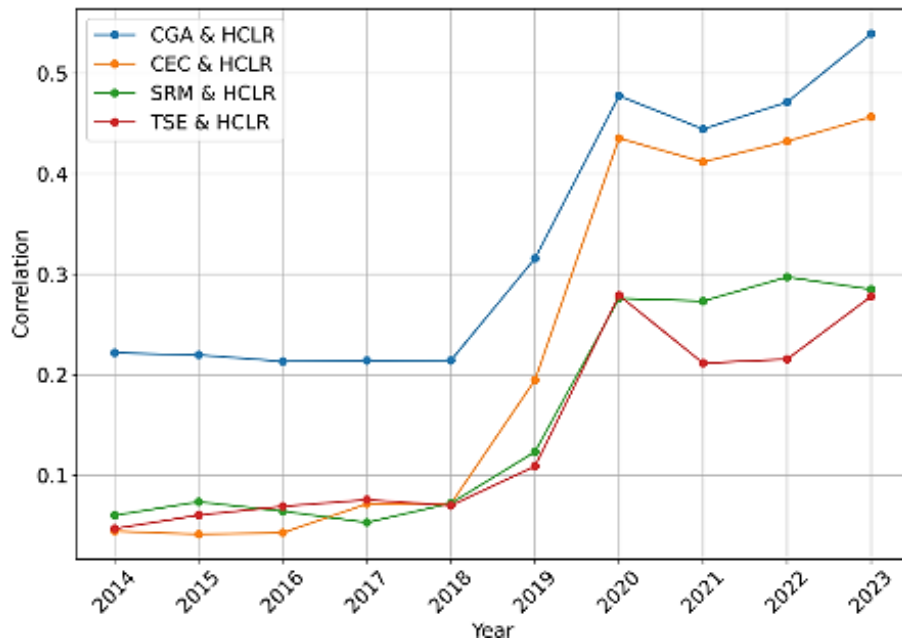
AISW = access inclusivity and social welfare; CEC = corporate ethics and compliance; CEHR = community engagement and human rights; CDR = customer and digital responsibility; CEM = climate and energy management; CGA = corporate governance and accountability; EBP = ecological business practices; ESG = environmental, social, and governance; HCLR = human capital and labor rights; NRS = natural resource stewardship; PWM = pollution and waste management; SRM = strategic risk management; TSE = transparency and stakeholder engagement.
 Source: Authors' calculations.

Figure 4: Correlation among Corporate E, S, and G Materiality Disclosures



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(c) S x G



AISW = access inclusivity and social welfare; CEC = corporate ethics and compliance; CEHR = community engagement and human rights; CDR = customer and digital responsibility; CEM = climate and energy management; CGA = corporate governance and accountability; EBP = ecological business practices; ESG = environmental, social, and governance; HCLR = human capital and labor rights; NRS = natural resource stewardship; PWM = pollution and waste management; SRM = strategic risk management; TSE = transparency and stakeholder engagement.
Source: Authors' calculations.

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Environmental, Social, and Governance Materiality in XBRL Disclosures and its Performance Predictability

Evidence from Japan

To determine environmental, social, and governance (ESG) materiality trends in Japan, this paper analyzes textual data—in eXtensible Business Reporting Language (XBRL) format—from the annual securities reports of over 3,800 listed companies. The paper identifies both an increasing trend of environmental materiality disclosure and correlations among ESG materiality. The potential of XBRL data as an alternative source for predicting the sustainability and financial performance of companies is also evident in the relationship between materiality disclosure and the financial and climate performance of companies.

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