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Readiness for Mandatory Climate-Related Disclosures: A Tri-Jurisdictional Analysis of Governance Attributes in Australia, New Zealand and the United Kingdom

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ABSTRACT

We evaluate the preparedness of companies in Australia, New Zealand and the United Kingdom to comply with emerging mandatory climate-related disclosures (CRDs) aligned with TCFD recommendations, using their Carbon Disclosure Project (CDP) information. Our analysis also examines the corporate governance attributes influencing their readiness to disclose such information. The findings reveal a strong integration of the Governance aspect of TCFD-recommended disclosure, with an 86% alignment between CDP and TCFD disclosures in the Governance theme. However, lower alignment is observed for Strategy (50%) and Metrics and Targets (49%), highlighting the need for immediate improvements in these areas. Firms with more gender-diverse boards and the presence of a sustainability committee demonstrate greater readiness to comply with CRDs consistent with TCFD recommendations. These insights shed light on firms' readiness for emerging mandatory CRD across jurisdictions, especially considering the new IFRS sustainability standards. The results underscore the urgent need to enhance competencies in Strategy and Metrics and Targets, where alignment is weakest. Practically, by documenting these insights, we provide managers with early guidance on the implications of their current CRD practices. This is especially relevant for firms subject to, or soon to be impacted by, mandatory sustainability regulations in their jurisdictions. The findings hold paramount significance for managers, policymakers and regulators.

JEL Classification: M40, M41, M48

1 | Introduction

Stakeholders have intensified demand for companies to provide consistent and comparable climate-related information (Ehalaiye et al. 2024; Rogelj et al. 2018; Tsang, Frost, and Cao 2023). In response, the Financial Stability Board (FSB) established the Task Force on Climate-related Financial Disclosures (TCFD) in 2015 to develop consistent climate-related disclosures (CRDs) (Bingler et al. 2022; Jeanne, Demaria, and Rigot 2023; TCFD 2017). TCFD

recommendations provide forward looking information in key areas related to climate risks and opportunities associated with transitioning to lower emission economy (Bingler et al. 2022; Demaria and Rigot 2021; Ehalaiye et al. 2024; Ngo et al. 2023). Although voluntary, there has been significant interest for its adoption across jurisdictions. For instance, New Zealand (NZ) government, through the External Reporting Board (XRB), has mandated CRDs for about 200 large financial services organisations, including equity and debt issuers listed on the New Zealand Exchange from the 2023 financial

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year (Ehalaiye et al. 2024; Shaw 2020; XRB 2022). Relatedly, the United Kingdom has indicated that CRDs aligned with TCFD recommendations will be mandatory by 2025, with a phased-in implementation approach (HM Treasury 2023). In Australia, the Australian Prudential Regulation Authority and the Australian Securities and Investments Commission have endorsed TCFD-recommended CRDs (Chua et al. 2022). Certainly, the release of the International Financial Reporting Standards (IFRS) S1—General Requirements for Disclosure of Sustainability-related Financial Information, and S2—Climate-related Disclosures, respectively, based on TCFD recommendations in June 2023 further suggest an accelerating pace of CRD regulations on the horizon.¹

Insights into TCFD-recommended CRDs are emerging (David and Giordano-Spring 2022; Demaria and Rigot 2021; Ehalaiye et al. 2024; Jeanne, Demaria, and Rigot 2023; Ngo et al. 2023), though with a dearth of empirical evidence on firms' readiness and drivers of such preparedness. In this light, Ngo et al. (2023, 3711) called for research examining TCFD-recommended CRDs and corporate governance (CG) attributes, especially in jurisdictions where these recommendations are being promoted. Heeding this call, we investigate factors influencing firms' readiness to comply with TCFD-related disclosures focusing on the alignment of their Carbon Disclosure Project (CDP)² disclosures with TCFD recommendations. Specifically, we investigate the extent of alignment between information reported through CDP questionnaire and recommended TCFD disclosures of firms across three jurisdictions: Australia, New Zealand and the United Kingdom. In doing so, we examine the role of CG factors particularly *board gender diversity* and the presence of *sustainability committees*³ in influencing TCFD-CDP alignment (Gerged et al. 2023; Gul, Srinidhi, and Ng 2011). Thus, the study addresses two broad questions:

- i. To what extent are companies in Australia, New Zealand and the United Kingdom ready to comply with emerging CRDs based on the alignment of their CDP information with TCFD-recommended disclosures?
- ii. Do idiosyncratic CG attributes, such as *board gender diversity* and the presence of a *sustainability committee*, influence firms' readiness to disclose high-quality CRDs consistent with TCFD recommendations?

The relationship between board gender diversity and sustainability outcomes, as well as the role of sustainability committees, in TCFD-CDP-aligned disclosures remains underexplored and inconclusive. While some studies associate female board representation with improved sustainability-related actions (Gerged et al. 2023; Orazalin and Mahmood 2021; Yarram and Adapa 2021; Zampone et al. 2024) others, like Jeanne, Demaria, and Rigot (2023), find no significant impact of such on TCFD-related disclosures. Similarly, sustainability committees show mixed results, positively influencing CDP transparency but not TCFD compliance (Jeanne, Demaria, and Rigot 2023). This inconclusiveness highlights the need for further investigation, motivating our study.

Our findings reveal a strong integration of Governance disclosures, with an 86% alignment between CDP and TCFD. Risk Management follows at 61%, while Strategy (50%) and Metrics

and Targets (49%) show lower alignments, highlighting areas needing improvement. New Zealand firms lead in TCFD-aligned Governance disclosures (91%), yet Metrics and Targets have the lowest alignment across jurisdictions (55% in New Zealand, 50% in Australia and 48% in the United Kingdom). An intriguing trend reveals that while firm-year observations reporting climate-related information to CDP increased from 18% in 2018 to 23% in 2021, overall alignment with TCFD recommendations declined, suggesting a rise in reporting entities, often with less comprehensive CRD practices. Notably, the United Kingdom saw a significant rise in reporting firms, from 176 (11%) in 2018 to 596 (36%) in 2022, achieving the highest convergence rate with TCFD-recommended disclosures among all jurisdictions. Our subsequent multivariate regression analysis reveals that firms with a higher proportion of women and those with a sustainability committee are more likely to comply with TCFD requirements. This is in part attributed to women's social and environmental appreciation of stakeholders' climate demands, which facilitates a better carbon management strategy (García Martín and Herrero 2020; Liao, Luo, and Tang 2015; Orazalin and Mahmood 2021).

Our study makes several contributions. First, we develop a unique disclosure index based on CDP-TCFD-aligned data, offering a more accurate and comparable measure of firms' CRDs. Unlike previous studies relying on annual reports (e.g., David and Giordano-Spring 2022; Demaria and Rigot 2021; Ehalaiye et al. 2024), which faced inconsistencies in index item selection (Ngo et al. 2023), our index mitigates these limitations, enabling robust cross-sectional analysis. Second, responding to Ngo et al. (2023), we demonstrate the influence of board gender diversity and sustainability committees on CRDs, advancing understanding beyond prior studies in voluntary reporting settings (e.g., Ben-Amar, Chang, and McIlkenny 2017; Jeanne, Demaria, and Rigot 2023; Liao, Luo, and Tang 2015). This is especially relevant in jurisdictions with existing or impending CRD regulations. Third, we identify critical CRD areas requiring urgent action in Australia, New Zealand, and the United Kingdom, enhancing preparedness for comprehensive reporting aligned with emerging IFRS S2 requirements. Unlike single-country or sector-specific studies (e.g., David and Giordano-Spring 2022; Demaria and Rigot 2021; Ehalaiye et al. 2024), our tri-jurisdictional analysis provides broader insights into CRD practices.

The paper is structured as follows: the next section reviews prior literature and develops the main hypotheses, followed by the method and sample, results and discussion, and concludes with the study's key implications.

2 | Literature Review and Hypothesis Development

2.1 | Board Gender Diversity and TCFD Disclosures

Board gender diversity remains a widely debated phenomenon due to the cultural and social distinctions between different genders (Liao, Luo, and Tang 2015; Nicolò et al. 2024). Studies suggest that boards with gender diversity exhibit higher sensitivity to social and environmental concerns (Gerged et al. 2023;

García Martín and Herrero 2020), with most generally indicating a positive connotation (Byron and Post 2016; Dawar and Singh 2016; Orazalin and Mahmood 2021; Velte 2017; Yarram and Adapa 2021; Zampone et al. 2024), although some studies yield varied outcomes. Prado-Lorenzo and Garcia-Sanchez (2010) find that while the gender diversity level of board members does not significantly impact their research models, the presence of gender diversity positively influences disclosure of information on GHG emissions, even among environmentally sensitive companies. Notwithstanding, sex-based biases might diminish the contribution of female directors in environmental matters. For example, Galbreath (2011), based on a sample of 151 Australian firms, finds no significant association between women directors and environmental quality.

Contrastingly, several studies demonstrate a positive relationship between board gender diversity and carbon disclosure. Liao, Luo, and Tang (2015) analyse the 329 largest companies in the United Kingdom and found a significant positive association between gender diversity and the propensity to disclose GHG information. Ben-Amar, Chang, and McIlkenny (2017), based on Canadian listed firms, note that as the percentage of women on boards increases, there is a higher likelihood of voluntary CRD. Affirmingly, García Martín and Herrero (2020) examine 644 nonfinancial firms in the European Union for the period 2002–2017 and confirm a positive association between board gender diversity and firms' environmental performance. These findings correspond with Orazalin and Mahmood (2021) that emphasise the role of board diversity in environmental performance, similar with Yarram and Adapa (2021) and Zampone et al. (2024) that demonstrate its link to CSR and SDG reporting. A similar positive association between board gender diversity and carbon reduction initiatives is noted by Haque (2017), based on 256 non-financial UK firms sampled from 2002 to 2014, and Tingbani et al. (2020) using 215 companies in the London Stock Exchange. Thus, these studies provide valuable insights into the ongoing discussion concerning the role of women in the boardroom.

The association between women on boards and CRDs can largely be understood from various theoretical perspectives. Firstly, *socialisation theory* posits that women are socialised to possess traits that promote a participative, democratic and communal leadership style (Gerged et al. 2023; Zelezny, Chua, and Aldrich 2000). Consequently, female directors may bring diverse perspectives to the boardroom, leading to more informed and higher quality decision-making focused on environmental concerns (Zampone et al. 2024). In this regard, Yarram and Adapa's (2021) study documents that meaningful representation of women on boards (beyond tokenism) significantly enhances positive CSR initiatives and mitigates negative corporate behaviours. Women's emphasis on quality of life and environmental issues establishes a direct link to environmental matters (Hofstede and Minkov 2010). With their unique experiences, knowledge and qualifications, female directors are likely to positively impact decision-making processes and contribute to firms' environmental sustainability outcomes (Carpenter 2002; Hillman, Shropshire, and Cannella 2007; Zampone et al. 2024). According to *stakeholder theory*, having women on the board enhances connections with stakeholders, thereby promoting greater accountability through information disclosures on environmental objectives (Ferdous, Rana, and

Yeboah 2024; Hussain, Rigoni, and Orij 2018). As highlighted by Nicolò et al. (2024) and Butt et al. (2024), stakeholder theory contends that firms must address the interests of diverse stakeholders, and women on boards are strategic in accomplishing this aim. Accordingly, they play a crucial role in environmental politics and decisions related to CRD.

Based on theoretical underpinnings and prior literature's postulation of a positive relationship between board gender diversity and CRD, gender-diverse boards will arguably exhibit greater sensitivity to climate-related issues. Likewise, as stakeholders increasingly demand transparency and accountability regarding companies' environmental impact (Ferdous, Rana, and Yeboah 2024), particularly their climate-related activities, boards with diverse gender representation, especially those surpassing the critical mass threshold (Joecks, Pull, and Vetter 2013; Yarram and Adapa 2021), are more likely to proactively address these expectations by complying with CRD consistent with the TCFD recommendations. Female directors, with their unique perspectives and heightened environmental awareness, may significantly contribute to enhancing the quality of companies' CRD typical of TCFD-recommended disclosures in response to stakeholders' demands and regulatory requirements. Consequently, the following hypothesis is proposed:

H1. *Ceteris paribus, the presence of a critical mass of women on boards is positively associated with improved CRDs.*

2.2 | Sustainability Committees and TCFD Disclosure

The presence of a sustainability committee is arguably considered as a signal for a firm's commitment to sustainable outcomes (Ricart, Rodríguez, and Sanchez 2005; Zampone et al. 2024), and its concern for environmental risk management (Haque 2017; Hussain, Rigoni, and Orij 2018). As explained by Zampone et al. (2024), sustainability committees serve as a platform for discussing and implementing sustainability-related policies, influenced by the diverse perspectives of board members. Although sustainability committees exist to promote incremental CRD to stakeholders, there is no clear unanimity of such outcomes in the empirical literature. For instance, studies by Rupley, Brown, and Marshall (2012) and Tingbani et al. (2020) find no significant influence of sustainability committee presence on the quality of environmental disclosures. Similarly, Michelon and Parbonetti (2012) report an insignificant relationship between the existence of a sustainability committee and sustainability disclosure in their study of US and European companies based on data from 2003.

Contrastingly, several studies affirm a positive effect of sustainability committees on sustainability reporting and performance. Berthelot and Robert (2011) observe that companies with environmental committees demonstrate higher levels of GHG disclosures, based on a sample of 64 oil and gas firms in Canada. Using data from the FT500 and S&P500 between 2002 and 2006, Peters and Romi (2014) identify a positive link between GHG disclosures and board governance structures, including the presence of environmental committees. More recently, Zampone et al. (2024), using a global sample spanning 39 countries, highlight sustainability

committees as pivotal in influencing SDG disclosures and mediating their relationship with board gender diversity. Similarly, several other studies have reported positive correlations between sustainability committees and various aspects of CSR and carbon reporting (e.g., Amran, Lee, and Devi 2014; Arena, Bozzolan, and Michelin 2015; Liao, Luo, and Tang 2015; Orazalin and Mahmood 2021; Walls, Berrone, and Phan 2012).

Based on the preceding empirical studies, the presence of a sustainability committee can be considered a crucial CG mechanism in ensuring the quality of CRDs. This can be explained from various perspectives. Drawing from the social contract (Shocker and Sethi 1973) and legitimacy theories, organisations seek societal acceptance by conforming to expectations and values related to sustainability practices (Ehalaiye et al. 2024; Ferdous, Rana, and Yeboah 2024). Establishing a sustainability committee allows companies to showcase their commitment to sustainable practices, encouraging comprehensive CRDs. Complimentarily, the stakeholder theory emphasises the need for companies to meet the diverse expectations of various stakeholders (Ehalaiye et al. 2024; Freeman 1984; Freeman et al. 2010). Sustainability committees, equipped with expertise in sustainability-related matters, can effectively identify legitimate stakeholder demand for CRDs (Orazalin and Mahmood 2021; Velte and Stawinoga 2020) and develop sustainable business practices that reliably deliver quality CRDs (Ioannou and Serafeim 2017; Mahmood, Kouser, and Masud 2019; Mallin, Michelin, and Raggi 2013). The diverse skills and experiences of committee members foster a comprehensive approach to sustainability issues, resulting in higher quality reporting (Eberhardt-Toth 2017; Liao, Luo, and Tang 2015). Considering the ensuing discourse, we make our second supposition:

H2. *Ceteris paribus, the existence of a sustainability committee is positively associated with improved CRDs.*

3 | Research Methodology

3.1 | Sampling Process

Data for our primary variable of interest were sourced from the CDP for firms in Australia, New Zealand and the United Kingdom from 2018 to 2022.⁴ To evaluate the extent of firms' preparedness to comply with TCFD requirements, we mapped the CDP-reported information of the sampled companies against our TCFD disclosure template, which was used to construct the TCFD Index (discussed in the next subsection). The CDP measures, monitors, assesses and discloses companies' emission performance and climate change actions (Jeanne, Demaria, and Rigot 2023). In 2019, the CDP integrated a climate change questionnaire⁵ that included additional TCFD-aligned questions, further strengthening the rationale for using companies' CDP responses to assess their preparedness for complying with TCFD disclosures.⁶

Our construction and application of an index to map the TCFD recommendations with the CDP questionnaire is designed to develop a scoring mechanism that measures the extent of TCFD-aligned disclosures, serving as a proxy for assessing firms' preparedness for TCFD-related reporting. In the initial phase, the index utilises univariate data to assess the level of

TABLE 1 | Sample selection.

	Observation
Matched data from 2018 to 2022 based on firms' climate-related disclosure aligned with TCFD recommendations from their CDP information.	2039
Less: Eliminate observations where either private company or ISIN missing	(347)
Less: Eliminated observations where either independents or other variables were missing	(335)
Final sample	1357

preparedness among the sampled firms. The preliminary dataset comprises 2039 firm-year observations based on the CDP-TCFD-aligned template, providing an unfiltered sample that is instrumental in addressing our first research question. In the second phase, we match the TCFD Index data by firm and year with each firm's financial data using their ISIN identifier. After filtering for missing data, 347 firm-year observations are excluded due to missing ISINs, or the firms being privately held with no publicly available financial data. Additionally, 335 observations are excluded due to missing independent variables or other control variables. This results in a final dataset of 1357 firm-year observations spanning three jurisdictions (see Table 1).

3.2 | Dependent Variable: TCFD Disclosure Index

We construct the TCFD disclosure index based on aligned CDP-reported information of the sampled companies. Our approach differs from prior studies (e.g., David and Giordano-Spring 2022; Demaria and Rigot 2021; Ehalaiye et al. 2024) that rely solely on annual reports of companies in developing their index measure, which has been argued to have inherent limitations due to inconsistencies and different construct approach (Ngo et al. 2023). We mitigate this problem using only information uniformly reported to the CDP and, thus, develop a more accurate and comparable measure for cross-sectional assessment. The TCFD is based on four principal themes: Governance, Strategy, Risk Management, and Metrics and Targets (Ehalaiye et al. 2024; TCFD 2017). These thematic areas collectively represent reporting entities' operations and are supported by key CRD, referred to as the 'recommended disclosures'. The recommended disclosures provide the supporting information that enables stakeholders to understand and evaluate companies' climate-related risks and opportunities.

In the development of the TCFD Index, we follow prior recommendations to guarantee the reliability and accuracy of our data (Bouten et al. 2011; Demaria and Rigot 2021; Ehalaiye et al. 2024). The process involves the creation of a grid template, as Bouten et al. (2011) describe, based on our CDP-TCFD-aligned recommended disclosures. This template serves as the foundation for determining the information required to be extracted from the CDP-reported data for each sampled company. Subsequently, one member of the research team meticulously aligns the CDP data of the sample companies with the TCFD

disclosures. A peer-checking process encompassing in-depth discussions on decision parameters with all members of the research team is implemented. The process ensures that each item coded by the first coder is reviewed by another team member for consistency and reliability. Whenever ambiguities arise, team members engage in careful deliberations to reach a consensus on a uniform approach. In cases where the agreed-upon approach necessitates the update of previously coded items for a company assessed earlier, the data for such entities are carefully reviewed.

The TCFD Index is based on a scoring system of 1 for each item reported to the CDP that aligns with TCFD-recommended information, and 0 otherwise. In total, 67 items must be present in a company's CDP-reported information to achieve full alignment with TCFD disclosures. These 67 items are distributed thematically as follows: 9 items in Governance, 21 in Strategy, 7 in Risk Management and 30 in Metrics and Targets.⁷ To ensure relative comparability across these thematic areas, each thematic category score is scaled by the total available items in that category to allow for a proportional score that reflects a company's alignment in that thematic area. For example, in 2019, the company Chorus receives an absolute score of 5 for Governance, which is then scaled by 9 (the total number of items available in that category), resulting in a proportional score of 0.56. We repeat this process across all three other thematic categories: Strategy (13/21 = 0.62), Risk Management (3/7 = 0.43), and Metrics and Targets (16/30 = 0.53). Subsequently, the proportional scores from the four thematic categories are aggregated (i.e., 0.56 + 0.62 + 0.43 + 0.53 = 2.14) to determine the overall TCFD score for the company in 2019. Given that the maximum thematic proportional score a company could attain from each category is 1 (indicating 100% alignment with the TCFD template), the maximum total TCFD score across all themes is 4.

3.3 | Independent Variables

We employ two independent variables in the test models: board gender diversity (*DIVERSITY*) and sustainability committee (*SUS_COMMITTEE*). We focus on these two variables as the idiosyncratic CG explanatory factors for possible TCFD implementation success. *DIVERSITY* is obtained from ASSET-4 as the percentage of women directors on the board of the sampled firm in year *t*, consistent with prior studies (Liao, Luo, and Tang 2015). *SUS_COMMITTEE* is a dummy variable with a value of 1 if the company has a board-level sustainability/environmental/CSR committee and 0 otherwise (Arena, Bozzolan, and Michelon 2015; Gerwing, Kajüter, and Wirth 2022; Liao, Luo, and Tang 2015). The *SUS_COMMITTEE* data are obtained from ASSET 4.

3.4 | Control Variables

Drawing on prior research (e.g., Jeanne, Demaria, and Rigot 2023; Katmon et al. 2019; Liao, Luo, and Tang 2015; Orazalin and Mahmood 2021) at the intersection of CG and sustainability, we include specific CG attributes as control variables for other possible CG drivers that influence firms' TCFD-aligned disclosures. These attributes include the following: board independence (*B_INDP*)—measured as the proportion of non-executive

directors to the total board size; audit committee independence (*AUDIT_COM_INDP*)—proportion of non-executive directors in the audit committee relative to its total size; and CEO duality (*CEO_DUAL*)—a binary variable scored 1 if the firm's chairman and CEO are the same individual, and 0 otherwise. Additionally, we account for firms' direct and indirect emission intensity using data from *SCOPES* 1, 2 and 3 emissions (Bui, Moses, and Houqe 2020; Butt et al. 2024) to address GHG emissions. *SCOPE1* emissions represent direct emissions from sources owned or controlled by the firm. *SCOPE2* covers indirect emissions from the consumption of purchased electricity, heat or steam. *SCOPE3*, on the other hand, represents indirect emissions within a firm's value chain, both upstream (e.g., purchased goods and services) and downstream (e.g., product use and disposal), which are not directly controlled by the firm. Butt et al. (2024) advance strategies for reducing Scope 3 emissions through supplier engagement via practices such as trust-building, data utilisation and incentive programmes, which are critical for aligning supplier actions with corporate sustainability goals.

Furthermore, we include firm-specific financial measures: firm size (*FIRMSIZE*)—measured as the natural logarithm of total assets (Al-Tuwajri, Christensen, and Hughes Ii 2004); turnover (*TURNOVER*)—calculated as total sales divided by total assets in year *t*; growth prospects (*TOBINSQ*)—measured as the sum of the market value of equity plus the book value of total debt, scaled by total assets, which offers insights into the firm's growth opportunities (Liang and Renneboog 2017); capital expenditure (*CAPX*)—calculated as total capital expenditure divided by total assets in year *t*, used as a proxy for long-term investment expenditure; leverage (*LEVERAGE*)—measured as total debt divided by total assets (Houqe et al. 2024); reporting quality (*REP_QUALITY*)—proxied by the natural logarithm of one plus the number of analysts following the firm in year *t*; and environmental sensitive industry (*ESI*)—an indicator for firms operating in pollution-intensive sectors (Bui, Moses, and Houqe 2020), included to account for industry-specific characteristics. At the country level, we incorporate the environmental performance index (*EPI*), a measure to gauge the extent of a country's commitment to climate change mitigation and environmental protection (Caby, Ziane, and Lamarque 2020). Finally, we include an Inverse Mill Ratio (*IMR*) to address potential endogeneity and self-selection bias, as well as year, industry and country fixed effects to control for temporal, sectoral and jurisdictional influences in our analytical models (Bui, Moses, and Houqe 2020).

3.5 | Estimation Models

To investigate the hypotheses conjectured above, we employ the following regression model:

$$\begin{aligned} \text{TCFD} = & \alpha_0 + \alpha_1 \text{DIVERSITY} + \alpha_2 \text{SUS_COMMITTEE} \\ & + \alpha_3 \text{B_INDP} + \alpha_4 \text{AUDIT_COM_INDP} \\ & + \alpha_5 \text{CEO_DUAL} + \alpha_6 \text{SCOPE1} + \alpha_7 \text{SCOPE2} \\ & + \alpha_8 \text{SCOPE3} + \alpha_9 \text{FIRMSIZE} + \alpha_{10} \text{TURNOVER} \quad (1) \\ & + \alpha_{11} \text{TOBINSQ} + \alpha_{12} \text{CAPX} + \alpha_{13} \text{LEVERAGE} \\ & + \alpha_{14} \text{REP_QUALITY} + \alpha_{15} \text{ESI} + \alpha_{16} \text{EPI} \\ & + \text{YEAR_FE} + \text{INDUSTRY_FE} + \text{COUNTRY_FE} \dots \end{aligned}$$

$$\begin{aligned}
TCFD = & \alpha_0 + \alpha_1 DIVERSITY_{t-1} + \alpha_2 SUS_COMMITTEE_{t-1} \\
& + \alpha_3 B_IND_{t-1} + \alpha_4 AUDIT_COM_INDP_{t-1} \\
& + \alpha_5 CEO_DUAL_{t-1} + \alpha_6 SCOPE1_{t-1} + \alpha_7 SCOPE2_{t-1} \\
& + \alpha_8 SCOPE2_{t-1} + \alpha_9 FIRMSIZE_{t-1} \\
& + \alpha_{10} TURNOVER_{t-1} + \alpha_{11} TOBINSQ_{t-1} + \alpha_{12} CAPX_{t-1} \\
& + \alpha_{13} LEVERAGE_{t-1} + \alpha_{14} REP_QUALITY_{t-1} \\
& + \alpha_{15} ESI_{t-1} + \alpha_{16} EPI + YEAR_FE \\
& + INDUSTRY_FE + COUNTRY_FE \dots
\end{aligned} \tag{2}$$

Model (1) is employed to estimate the contemporaneous relation between TCFD-aligned disclosures, board gender diversity and the presence of a sustainability committee during the same period (t). Model (2), on the other hand, examines the outcome of their relationship based on a 1-year lead-lag effect. Detailed definition of all variables is contained in Appendix B.

4 | Results and Discussion

4.1 | Descriptive Statistics

Table 2 presents the sample distribution across industries, countries and years. The majority of firms operate in the service industry (28.52%), followed by manufacturing (15.55%) and infrastructure (12.90%). Together, these three sectors comprise approximately 57% of the sampled firms. In contrast, the mineral extraction industry (2.36%) and apparel sector (1.40%) have the lowest representation in the sample. Regarding the distribution across countries, the United Kingdom dominates the sample with 1024 observations, representing 75.46% of the total. Australia follows with 261 observations (19.23%), while New Zealand has the fewest, with 72 observations (5.31%). Throughout the sampling period, there is a clear upward trend in the number of firms reporting CRD aligned with TCFD recommendations through the CDP. In 2018, 17.61% of firms reported such disclosures, rising to 23.21% by 2022, consistent with prior findings (e.g., David and Giordano-Spring 2022; Demaria and Rigot 2021; Ehalaiye et al. 2024). This might suggest signs of growing maturity in CRD across time and jurisdictions.

Table 3 provides an overview of variables' descriptive statistics. The mean for *TCFD* is 2.9192, with a minimum (maximum) of 0.0700 (3.9700), suggesting an average alignment of 73%.⁸ The median score for *TCFD* is 3.0600, indicating that half of the sampled companies' CRDs have over 77% alignment with TCFD disclosures. This could signify positive progress in TCFD-recommended disclosures, although the standard deviation of 0.6431 suggests a relatively wide dispersion in the alignment, as evident in the range of the *TCFD* score of 3.900 (i.e., minimum of 0.0700 and maximum of 3.9700).

The mean of *DIVERSITY* is 0.3380, indicating that, on average, women make up approximately 34% of the boards, with the highest and lowest percentages being 71% and 10%, respectively. This suggests that, on average, firms' *DIVERSITY* surpass the critical mass threshold of 30% (Joecks, Pull, and

TABLE 2 | Sample distribution by industry, country and year.

Panel A: sample distribution by industry		
Industry	# observations	%
Apparel	19	1.40
Biotech	63	4.64
Food	77	5.67
Fossil fuels	45	3.32
Hospitality	47	3.46
Infrastructure	175	12.90
Manufacturing	211	15.55
Materials	97	7.15
Mineral extraction	32	2.36
Power generation	39	2.87
Retail	126	9.29
Service	387	28.52
Transportation	39	2.87
Total	1357	100
Panel B: sample distribution by country		
Country	Observations	%
Australia	261	19.23
New Zealand	72	5.31
UK	1024	75.46
Total	1357	100
Panel C: sample distribution by year		
Year	Observations	%
2018	239	17.61
2019	259	19.09
2020	266	19.60
2021	278	20.49
2022	315	23.21
Total	1357	100

Vetter 2013; Yarram and Adapa 2021), although some firms still have as low as 10% women directors. The mean (median) score for *SUS_COMMITTEE* is 0.6133 (1), signifying that around 61% of the sampled companies have a dedicated sustainability committee. However, the standard deviation of 0.3966 points to considerable variation across the sample. On average, 68% of the directors on sampled firms' boards are non-executive directors (*B_INDP*=0.6874). The mean (median) score for *AUDIT_COM_INDP* is 0.8429 (1), indicating that about 84% of audit committee members within these firms are non-executive directors. In terms of CEO duality, the mean is 0.0834, suggesting that around 8% of the sampled firms have a chairman who also serves as CEO.

TABLE 3 | Descriptive statistics.

Variable(s)	Mean	SD	Min	P25	Median	P75	Max
<i>TCFD</i>	2.9192	0.6431	0.0700	2.6800	3.0600	3.3500	3.9700
<i>DIVERSITY</i>	0.3380	0.1022	0.1000	0.2857	0.3333	0.4000	0.7143
<i>SUS_COMMITTEE</i>	0.6133	0.3966	0.0000	0.0000	1.0000	1.0000	1.0000
<i>B_INDP</i>	0.6874	0.1572	0.0000	0.6000	0.7000	0.8000	1.0000
<i>AUDIT_COM_INDP</i>	0.8429	0.3448	0.0000	1.0000	1.0000	1.0000	1.0000
<i>CEO_DUAL</i>	0.0834	0.2767	0.0000	0.0000	0.0000	0.0000	1.0000
<i>SCOPE1</i>	0.0607	0.1413	0.0002	0.0012	0.0075	0.0331	0.6679
<i>SCOPE2</i>	0.0203	0.0338	0.0005	0.0023	0.0073	0.0224	0.1721
<i>SCOPE3</i>	0.2700	0.6022	0.0008	0.0032	0.0254	0.2704	0.4544
<i>FIRMSIZE</i>	15.0536	1.6444	12.5374	13.8435	14.8998	15.9911	18.7550
<i>TURNOVER</i>	0.6504	0.5204	0.0339	0.1609	0.5602	0.9249	1.8242
<i>TOBINSQ</i>	1.8456	1.3144	0.6899	1.0541	1.3550	1.9244	9.5789
<i>CAPX</i>	0.0299	0.0311	0.0000	0.0062	0.0198	0.0455	0.1811
<i>LEVERAGE</i>	0.1913	0.1384	0.0000	0.0671	0.1858	0.2872	0.4756
<i>REP_QUALITY</i>	2.0884	0.2510	1.0000	1.9871	2.0525	2.2844	2.5612
<i>ESI</i>	0.3586	0.4798	0.0000	0.0000	0.0000	1.0000	1.0000
<i>EPI</i>	78.3691	4.2638	60.1000	77.7000	79.8900	81.3000	81.3000

For SCOPES 1, 2 and 3, the mean scores are 0.0607, 0.0203 and 0.2700, respectively, suggesting that on average, the sampled firms have higher indirect emission intensity within their value chain (i.e., *SCOPE3* = 27%) compared to *SCOPE1* (i.e., 6%) and their other indirect emissions (*SCOPE2* = 2%). The mean values for other variables include *FIRMSIZE* at 15.0536, *TURNOVER* at 65%, *TOBINSQ* at 1.8456, *CAPX* at 0.0299 and *LEVERAGE* at 19%. *REP_QUALITY* has a mean of 2.0884, indicating the presence of analysts following the sampled firms. Additionally, *ESI* has a mean value of 0.3586, reflecting that approximately 36% of the firms operate in environmentally sensitive industries. This is consistent with the distribution shown in Table 2, where high-emission sectors, such as transportation, mineral extraction and apparel, have fewer observations. Lastly, *EPI*, which measures the country-level environmental performance index, has a mean of 78.3691, suggesting that the sampled countries generally exhibit a strong commitment to climate action (Moses et al. 2022).

4.2 | Correlation Matrix

In Table 4, we present the pairwise correlation matrix. TCFD demonstrates a positive and statistically significant relationship with both *DIVERSITY* (0.1168) and *SUS_COMMITTEE* (0.2431) at the 1% significance level, offering preliminary support for our two hypotheses. However, definitive confirmation will follow from the subsequent multiple regression analyses.

Additionally, TCFD shows statistically significant positive correlations with *SCOPE1* (0.1121), *SCOPE2* (0.0810), *SCOPE3* (0.0911), *FIRMSIZE* (0.3991), *LEVERAGE* (0.0922),

REP_QUALITY (0.2247), *ESI* (0.1454) and *EPI* (0.0608) at conventional levels. In contrast, *TURNOVER* (−0.1011) and *TOBINSQ* (−0.2466) are negatively correlated with TCFD, with both relationships being significant at the 1% level. On the other hand, *B_IND* (0.0093), *AUDIT_COM_INDP* (0.0820) and *CAPX* (0.0317) exhibit positive correlations with TCFD, while *CEO_DUAL* (−0.0311) shows a negative association. However, these relationships are not statistically significant at conventional thresholds.

4.3 | Main Results

4.3.1 | CRD Readiness in Australia, New Zealand and the United Kingdom

We begin our analysis by exploring reporting trends across thematic areas of alignment with TCFD-recommended disclosures. As illustrated in Figure 1, there is an impressive 86% alignment between CDP and TCFD disclosures within the Governance theme. This high level of alignment can likely be attributed to firms integrating governance-related risk disclosures (Bingler et al. 2022), influenced by stringent CG requirements established over the past two decades (Ben-Amar, Chang, and McIlkenny 2017; Bui, Moses, and Houque 2020). This has resulted in enhanced climate-related governance practices in line with TCFD recommendations (David and Giordano-Spring 2022; Demaria and Rigot 2021; Ehalaiye et al. 2024).

Risk Management follows with a 61% alignment, suggesting that firms have demonstrated compliance capabilities in this area. However, Strategy and Metrics and Targets show much lower

TABLE 4 | Correlation matrix.

Variable(s)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
<i>TCFD</i> (1)	1.0000																
<i>DIVERSITY</i> (2)	0.1168 (<0.01)	1.0000															
<i>SUS_COMMITTEE</i> (3)	0.2431 (<0.01)	0.1143 (<0.01)	1.0000														
<i>B_INDP</i> (4)	0.0093 (0.78)	0.2005 (<0.01)	0.0472 (0.17)	1.0000													
<i>AUDIT_COM_INDP</i> (5)	0.0820 (0.01)	0.1156 (<0.01)	0.0551 (0.11)	0.0964 (<0.01)	1.0000												
<i>CEO_DUAL</i> (6)	-0.0311 (0.36)	-0.1262 (<0.01)	-0.0687 (<0.05)	-0.1749 (<0.01)	-0.1765 (<0.01)	1.0000											
<i>SCOPE1</i> (7)	0.1121 (<0.01)	-0.1138 (<0.01)	0.1930 (<0.01)	0.0646 (<0.10)	-0.0107 (0.77)	0.0355 (0.35)	1.0000										
<i>SCOPE2</i> (8)	0.0810 (<0.05)	-0.0459 (0.21)	0.1349 (<0.01)	0.0162 (0.66)	0.0440 (0.23)	-0.0308 (0.40)	0.4738 (<0.01)	1.0000									
<i>SCOPE3</i> (9)	0.0911 (<0.05)	0.0184 (0.68)	0.1549 (<0.01)	-0.0757 (<0.10)	0.0212 (0.63)	0.0609 (0.17)	0.5462 (<0.01)	0.4608 (<0.01)	1.0000								
<i>FIRMSIZE</i> (10)	0.3991 (<0.01)	0.1169 (<0.01)	0.1814 (<0.01)	0.3240 (<0.01)	0.3212 (<0.01)	-0.0589 (<0.10)	-0.0241 (0.52)	-0.0850 (<0.05)	0.0038 (0.93)	1.0000							
<i>TURNOVER</i> (11)	-0.1011 (<0.01)	0.0026 (0.94)	0.0719 (<0.05)	-0.1122 (<0.01)	-0.0407 (0.20)	0.0818 (<0.05)	-0.0382 (0.30)	-0.0842 (<0.05)	0.0178 (0.69)	-0.3833 (0.729)	1.0000						
<i>TOBINSQ</i> (12)	-0.2466 (<0.01)	0.0355 (0.32)	-0.1391 (<0.01)	-0.0254 (0.24)	0.0081 (0.32)	-0.1375 (<0.10)	0.1811 (<0.01)	0.0110 (0.54)	0.2145 (0.729)	0.0110 (0.33)	0.2314 (<0.01)	1.0000					
<i>CAPX</i> (13)	0.0317 (0.32)	-0.1017 (<0.01)	0.1142 (<0.01)	-0.1181 (<0.01)	0.0566 (<0.10)	0.0288 (0.40)	0.3493 (<0.01)	0.3874 (<0.01)	0.0729 (0.11)	-0.1339 (0.729)	0.0475 (0.13)	0.0124 (0.15)	1.0000				
<i>LEVERAGE</i> (14)	0.0922 (<0.01)	-0.0321 (0.35)	0.1021 (<0.01)	0.0258 (0.45)	0.0742 (<0.05)	-0.0280 (0.41)	0.1741 (<0.01)	0.1656 (<0.01)	-0.0092 (0.83)	0.1476 (0.729)	-0.1219 (<0.01)	0.0159 (0.26)	0.3628 (<0.01)	1.0000			
<i>REP_QUALITY</i> (15)	0.2247 (<0.01)	0.1174 (<0.01)	0.0530 (0.21)	0.1042 (<0.05)	0.1147 (<0.01)	0.0129 (0.76)	-0.0067 (0.88)	-0.0568 (0.21)	-0.0710 (0.18)	0.2766 (0.729)	-0.0561 (0.18)	0.2100 (<0.01)	-0.1043 (<0.05)	0.0962 (<0.05)	1.0000		
<i>ESI</i> (16)	0.1454 (<0.10)	-0.0116 (0.96)	0.0219 (0.52)	-0.0369 (0.28)	0.0555 (<0.10)	0.0377 (0.27)	0.1306 (<0.01)	0.1036 (<0.01)	0.1218 (<0.01)	-0.0447 (0.16)	0.0257 (0.42)	0.0081 (0.54)	0.0396 (0.21)	-0.0237 (0.46)	-0.0607 (0.15)	1.0000	
<i>EPI</i> (17)	0.0608 (<0.05)	-0.0558 (0.10)	0.0019 (0.95)	-0.1289 (<0.01)	-0.0942 (<0.01)	-0.1286 (<0.01)	-0.1452 (<0.01)	-0.0774 (<0.05)	-0.0179 (0.69)	-0.1665 (0.729)	0.1343 (>0.01)	0.0120 (0.69)	-0.0224 (0.48)	-0.0387 (0.22)	-0.0559 (0.18)	0.2141 (>0.01)	1.0000

Note: Statistical significance in the parenthesis respectively (two-tailed tests).

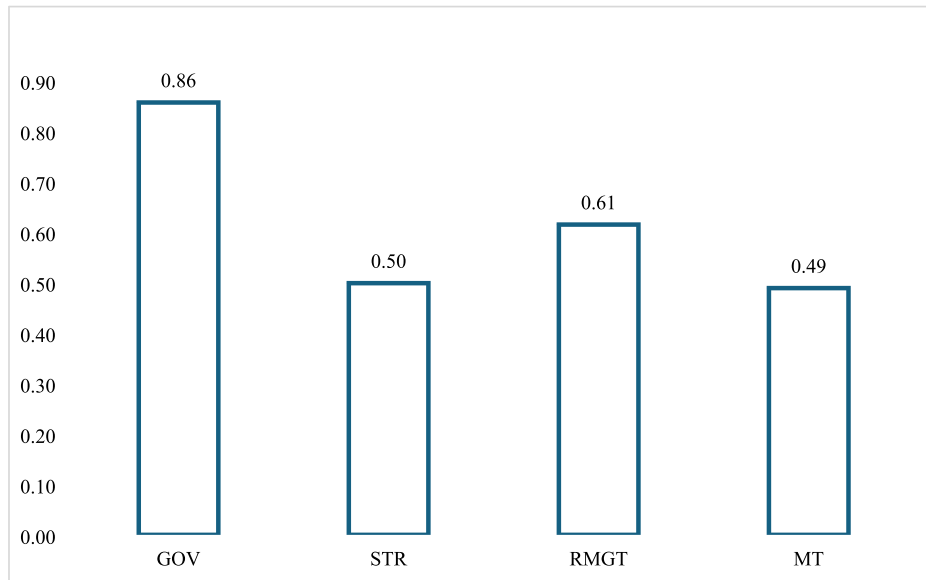


FIGURE 1 | TCFD thematic alignment.

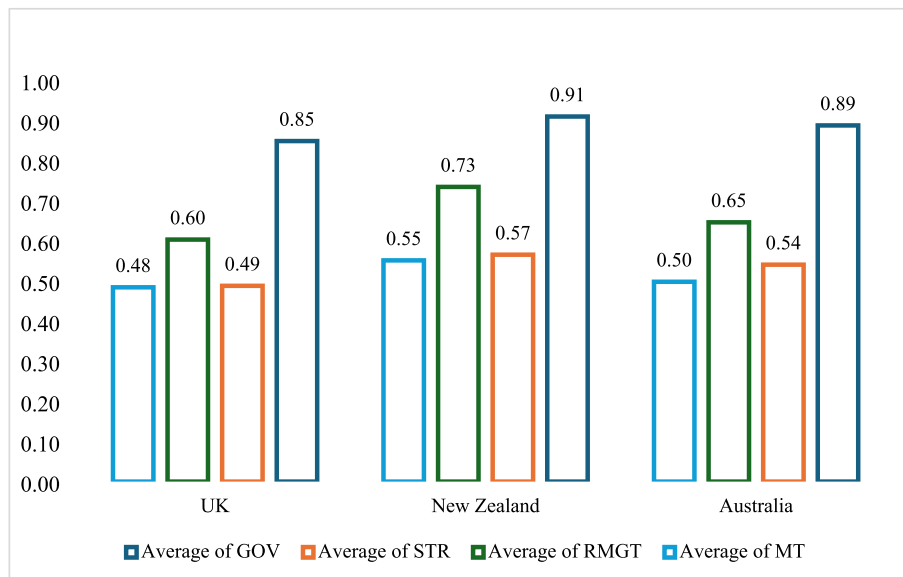


FIGURE 2 | TCFD thematic alignment across countries.

alignment, at around 50% and 49%, respectively. Metrics and Targets, with the lowest alignment (49%), reflects a concerning trend, highlighting the extent to which the sampled companies still struggle to meet disclosure requirements in this category. Binger et al. (2022) observe uneven progress across TCFD categories, with firms performing better in Governance and Risk Management, while Strategy and Metrics and Targets remain comparatively weak. Indeed, disclosures related to Strategy and Metrics tend to lag behind those in Governance and Risk Management (David and Giordano-Spring 2022; Ngo et al. 2023), potentially due to the high costs and technical expertise required to generate and report such detailed information (Ehalaiye et al. 2024; Swart, Raskin, and Robinson 2004). The costs associated with providing specific CRDs, especially in the absence of mandatory requirements, may explain the lower levels of alignment in these areas. Prior studies have provided evidence of the financial burden associated with reporting

(Bui, Moses, and Houqe 2020; Moses, Houqe, and van Zijl 2018; Moses, van Zijl, and Houqe 2021). Hence, to the extent that is practicable without regulatory mandates, firms may rationally avoid incurring additional costs for disclosures that exceed what is strictly necessary.

Figure 2 illustrates the level of firms' TCFD thematic disclosure alignment across jurisdictions. Overall, firms in all three regions show a consistently high level of alignment in the Governance theme, with average scores of 91% in New Zealand, 89% in Australia and 85% in the United Kingdom (David and Giordano-Spring 2022; Demaria and Rigot 2021). This indicates strong adherence to governance-related disclosures across these jurisdictions. In stark contrast, the Metrics and Targets theme exhibits the lowest alignment, with averages of 55% in New Zealand, 50% in Australia and 48% in the United Kingdom. This trend highlights a critical gap, suggesting that

significant improvement is needed in this area. The low alignment in Metrics and Targets may be attributed to the technical complexity and specialised expertise required for certain disclosures (Ehalaiye et al. 2024; Swart, Raskin, and Robinson 2004), which may pose challenges for firms. Consequently, while entities may recognise the value of CRD, they may be constrained by the technical demands, limiting their CRDs alignment with TCFD requirements.

Focusing on the level of alignment over time and across jurisdictions, we observe a notable exponential uptake in the United Kingdom compared to Australia and New Zealand (see Table 5A and Figure 3). In the United Kingdom, there is a significant upward trend in the number of reporting entities, starting with 176 firms in 2018, representing 11% of all sampled UK entities, increasing to 596 firms (36%) in 2022. This represents the highest convergence rate towards TCFD-recommended disclosures across all jurisdictions. A possible explanation for this rapid growth could be the anticipated mandatory CRD regime in the United Kingdom (HM Treasury 2023). In contrast, the more gradual change in New Zealand and Australia could be attributed to their long-standing practices in sustainability and environmental reporting, particularly in line with Global Reporting Initiative and Integrated Reporting frameworks (Ehalaiye et al. 2024). These jurisdictions may be approaching a

saturation point with respect to CRD in-scope entities, resulting in marginal increases in the number of new reporting entities over the years.

A more granular examination of TCFD-aligned thematic disclosures by year and jurisdiction provides further insights into these trends (Tables 5B–5D). One interesting observation is the declining rate of proportional alignment in the Governance (GOV) theme across all jurisdictions. For instance, in 2018, Australia, New Zealand and the United Kingdom had GOV alignment rates of 93%, 91% and 98%, respectively. However, by 2022, these rates had dropped to 82%, 86% and 78%, respectively. This decline may be due to new entities entering the CDP reporting pool with limited expertise in CRD, or possibly due to firms strategically omitting TCFD-aligned information, especially as no mandate demands such (Metzner and Mikes 2021). A similar downward trend is observed across all thematic areas, suggesting a widespread decline in alignment proportions over time. This trend highlights potential challenges in maintaining high-quality CRDs as more entities are required to report, possibly necessitating additional support and regulatory pressure to sustain alignment across jurisdictions.

We also examine the extent of TCFD-aligned reporting trends across industries within the sampled firms in Table 6.

TABLE 5A | Aggregate TCFD-aligned disclosures trend by year and country.

Year	Australia		New Zealand		United Kingdom		Total	
	N	%	N	%	N	%	N	%
2018	53	18%	10	12%	176	11%	239	12%
2019	49	16%	13	15%	190	11%	252	12%
2020	60	20%	18	21%	276	17%	354	17%
2021	66	22%	22	26%	418	25%	506	25%
2022	69	23%	23	27%	596	36%	688	34%
Total	297	100%	86	100%	1656	100%	2039	100%

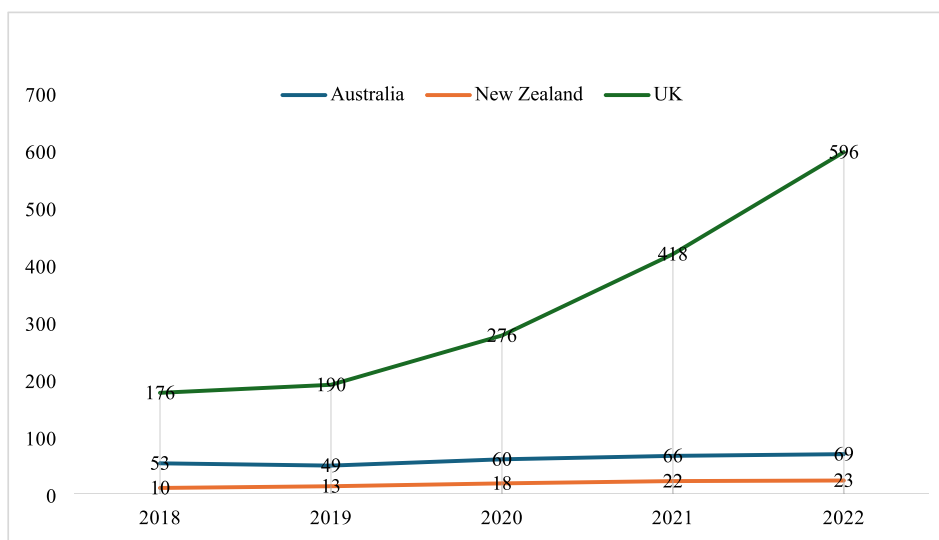


FIGURE 3 | TCFD reporting trend across time.

TABLE 5B | Australia TCFD-aligned thematic disclosures by year.

Year	N	TCFD	GOV	STR	RMGT	MT
2018	53	2.78	93%	58%	73%	53%
2019	49	2.86	96%	62%	74%	55%
2020	60	2.48	87%	51%	63%	47%
2021	66	2.56	89%	52%	65%	50%
2022	69	2.29	82%	50%	52%	45%
Total	297	2.57	89%	54%	65%	50%

TABLE 5C | New Zealand TCFD-aligned thematic disclosures by year.

Year	N	TCFD	GOV	STR	RMGT	MT
2018	10	2.84	91%	56%	81%	56%
2019	13	2.94	92%	64%	76%	62%
2020	18	2.80	93%	58%	75%	54%
2021	22	2.86	94%	57%	79%	55%
2022	23	2.50	86%	51%	61%	52%
Total	86	2.76	91%	57%	73%	55%

TABLE 5D | UK TCFD-aligned thematic disclosures by year.

Year	N	TCFD	GOV	STR	RMGT	MT
2018	176	298%	98%	61%	80%	59%
2019	190	302%	98%	64%	80%	60%
2020	276	256%	88%	50%	67%	51%
2021	418	227%	81%	43%	57%	46%
2022	596	211%	78%	44%	47%	42%
Total	1656	242%	85%	49%	60%	48%

Power generation (82%) and fossil fuels (73%) emerge as the top two industries with the highest alignment in TCFD disclosures. This aligns with prior studies suggesting that firms operating in sectors with significant emission risks and potential regulatory mandates are more likely to comply with climate reporting requirements to mitigate stakeholder scrutiny (Ehalaiye et al. 2024). Additionally, our granular analysis (untabulated) reveals a qualitatively similar declining trend in alignment over the years, with the most recent reporting period showing the weakest alignment. This outcome mirrors the patterns documented in Tables 5B–5D, highlighting a broader challenge in maintaining high levels of CRDs consistent with TCFD recommendations across industries over time.

Albeit firm-year observations marginally increased from 18% in 2018 to 23% in 2022, the level of alignment over the sampling period declined (see Figure 4). While more firms reported to the CDP, the proportional alignment of reported information with TCFD recommendations decreased. In 2018

and 2019 for instance, we observe the highest alignments, reaching 73% and 75% for 18% and 19% of the reported firm-year observations in our sample, respectively. However, in 2022, the aligned proportion dropped to 54%, despite having the highest number of firm-year observations of 23%. One possibility could be that while an increasing number of firms are reporting to the CDP, only relatively few firms with prior experience in CRD continue to provide more accurate TCFD-aligned information over time. This inference suggests that the number of firms reporting their TCFD-aligned information remains relatively stagnant (i.e., with very minimal increase), even as the overall number of reporting firms within the CDP pool continues to increase. An alternate strategic perspective may infer that reporting companies continue doing so to CDP, however with declining intent to volunteer specific TCFD-aligned information (Bui and De Villiers 2017; Metzner and Mikes 2021).

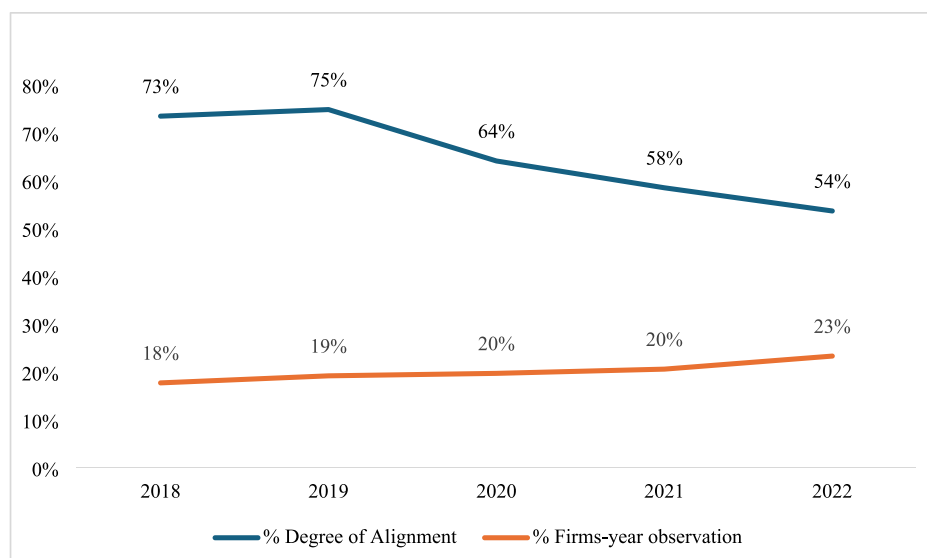
4.3.2 | Diversity and CRDs

In Model (1), reported in Table 7A, we estimate a contemporaneous model to test the immediate and concurrent effect of board gender diversity on the sampled firms' likelihood to comply with CRDs consistent with the TCFD-recommended disclosures. The observed coefficient on *DIVERSITY* (0.4213) is positive and statistically significant at the 5% level, indicating that companies with a higher percentage of women directors on their board are associated with better aligned TCFD disclosures (Byron and Post 2016; Dawar and Singh 2016; Velte 2017; Zampone et al. 2024), which confirms our first hypothesis. Consistent with our expectation and prior studies, the findings suggest that boards with gender diversity exhibit higher sensitivity to social and environmental concerns (García Martín and Herrero 2020; Orzalin and Mahmood 2021; Yarram and Adapa 2021; Zampone et al. 2024). The empirical inference based on the coefficient on *DIVERSITY* of 0.4213 suggests that on average, firms with a 0.3380 (i.e., 34%) proportion of women on their board are likely to have around 42%⁹ TCFD-aligned information already disclosed via CDP reporting. An inference suggests that firms operating with a relatively significant quotient of women on their board, especially a percentage above the critical mass level (Joecks, Pull, and Vetter 2013), are likely more ready for a CRD reporting regime.

In Column 2 of Table 7A, we estimate our main model, incorporating *SCOPE3* as an additional control variable. The results remain qualitatively similar, though the coefficient for *SCOPE3* is lower at 0.3989. This suggests that an increased carbon footprint within an entity's value chain has a measurable, albeit reduced, impact on the outcomes. This finding underscores the growing importance of addressing climate-related risks, particularly GHG emissions, across the entire value chain, given their influence on corporate performance and reporting outcomes (Butt et al. 2024). In the long term, this is a practical implication expected to be achieved through TCFD-aligned reporting (Moses et al. 2022; TCFD 2017; XRB 2022). By integrating CRDs, firms can enhance transparency and better manage risks, ultimately improving decision-making and stakeholder confidence (Ferdous, Rana, and Yeboah 2024; Gerged et al. 2023; Nicolò et al. 2024).

TABLE 6 | TCFD-aligned disclosures by industry.

Industry	TCFD	TCFD aligned %	GOV	STR	RMGT	MT
Apparel	2.39	60%	0.84	0.48	0.57	0.49
Biotech	2.31	58%	0.89	0.40	0.58	0.45
Food	2.46	61%	0.84	0.50	0.58	0.54
Fossil fuels	2.93	73%	0.98	0.60	0.80	0.55
Hospitality	2.26	57%	0.89	0.40	0.52	0.45
Infrastructure	2.71	68%	0.89	0.57	0.70	0.55
Manufacturing	2.17	54%	0.78	0.43	0.53	0.43
Materials	2.67	67%	0.92	0.54	0.70	0.51
Mineral extraction	2.69	67%	0.95	0.58	0.73	0.43
Power generation	3.28	82%	0.95	0.76	0.89	0.69
Retail	2.69	67%	0.91	0.57	0.68	0.52
Services	2.38	60%	0.84	0.48	0.59	0.47
Transportation	2.52	63%	0.86	0.50	0.63	0.53
Total	2.46	0.61	0.86	0.50	0.61	0.49

**FIGURE 4** | TCFD aligned disclosure and trend of reporting.

In Table 7B, we estimate a 1-year lead-lag model (Model 2) to assess the impact of the prior year's proportion of board diversity ($DIVERSITY_{t-1}$) on current-year alignment with TCFD disclosures. The coefficient for $DIVERSITY_{t-1}$ is 0.3219, positive and statistically significant at the 5% level. Although this coefficient is smaller compared to the contemporaneous model, the overall outcome remains qualitatively similar (Liao, Luo, and Tang 2015), reaffirming the finding from Model (1) that board gender diversity positively influences a firm's readiness to comply with CRDs aligned with TCFD recommendations. Theoretically, this finding underscores the importance of achieving a critical mass of women on boards. Women's unique experiences, knowledge and educational attainment are likely

to enhance decision-making processes, contributing positively to firms' sustainability outcomes (Carpenter 2002; Hillman, Shropshire, and Cannella 2007; Yarram and Adapa 2021). This is further supported by the socialisation perspective, which suggests that women, through their socialised traits, promote a participative, democratic and communal leadership style (Gerged et al. 2023; Zelezny, Chua, and Aldrich 2000), often focused on climate-related solutions (Zamponi et al. 2024). The effectiveness of diverse boards also addresses key stakeholders' concerns regarding CRDs. From a stakeholder theory perspective, the presence of women on boards fosters stronger connections with stakeholders, enhancing accountability and promoting greater transparency through disclosures on

TABLE 7A | Contemporaneous effect regression analysis.

Variable(s)	Model (1): contemporaneous effect	
	(1)	(2)
	Coeff. (t-value)	Coeff. (t-value)
<i>DIVERSITY</i>	0.4213** (2.25)	0.3989** (2.19)
<i>SUS_COMMITTEE</i>	0.2119*** (4.28)	0.1999*** (3.78)
<i>B_INDP</i>	0.0012 (1.15)	0.0011 (0.98)
<i>AUDIT_COM_INDP</i>	0.0140 (1.46)	0.0159* (1.68)
<i>CEO_DUAL</i>	-0.0001 (-0.84)	-0.0001 (-0.64)
<i>SCOPE1</i>	0.2549* (1.81)	0.2945** (1.96)
<i>SCOPE2</i>	0.8845** (2.54)	0.8941** (2.12)
<i>SCOPE3</i>		0.4412** (2.10)
<i>FIRMSIZE</i>	0.1245*** (6.12)	0.1018*** (4.13)
<i>TURNOVER</i>	-0.1317*** (-3.72)	-0.1097*** (-3.26)
<i>TOBINSQ</i>	0.0908*** (6.28)	0.0810*** (5.71)
<i>CAPX</i>	2.4510*** (3.92)	1.1120* (1.76)
<i>LEVERAGE</i>	0.2199** (1.98)	0.1986* (1.81)
<i>REP_QUALITY</i>	0.3321*** (3.67)	0.3011*** (3.21)
<i>ESI</i>	-0.2412*** (-4.11)	-0.2010*** (-3.11)
<i>EPI</i>	0.0111** (2.29)	0.0090** (2.15)
<i>CONSTANT</i>	1.3524*** (7.59)	0.1245 (1.12)
<i>YEAR_FE</i>	Yes	Yes
<i>INDUSTRY_FE</i>	Yes	Yes
<i>COUNTRY_FE</i>	Yes	Yes
F-Stat	28.26***	24.32***
Adj. R ²	0.2985	0.3015
N	1357	1174

Note: This table reports the estimation of the determinants of TCFD disclosure based on a contemporaneous effect. Heteroscedasticity-robust standard errors clustered at firm level are shown in parentheses.

*, ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed tests).

environmental strategies (Ferdous, Rana, and Yeboah 2024; Hussain, Rigoni, and Orij 2018; Nicolò et al. 2024). In Column 2, we apply a similar approach as in Table 7A by including *SCOPE3* as a control variable. The results are consistent with the prior analysis, though the coefficient for *DIVERSITY*_{*t*-1} decreases slightly to 0.2866. This further supports the conclusion that diversity remains an important factor in driving effective TCFD alignment, even when controlling for broader emissions across the value chain.

4.3.3 | Sustainability Committee and CRDs

To address our second hypothesis, we rely on the estimation results presented in Tables 7A and 7B. In Model (1), we estimate the contemporaneous effect of the presence of a sustainability

TABLE 7B | Lead-lag effect regression analysis.

Variable(s)	Model (2): 1-year lagged effect	
	(1)	(2)
	Coeff. (t-value)	Coeff. (t-value)
<i>DIVERSITY</i> _{<i>t</i>-1}	0.3219** (2.08)	0.2866** (2.11)
<i>SUS_COMMITTEE</i> _{<i>t</i>-1}	0.2477*** (3.69)	0.2671*** (3.11)
<i>B_INDP</i> _{<i>t</i>-1}	0.0024 (1.61)	0.0014 (1.09)
<i>AUDIT_COM_INDP</i> _{<i>t</i>-1}	0.0127 (1.22)	0.0156* (1.67)
<i>CEO_DUAL</i> _{<i>t</i>-1}	-0.0002 (-0.68)	-0.0001 (-0.42)
<i>SCOPE1</i> _{<i>t</i>-1}	0.4278** (2.52)	0.4164** (2.33)
<i>SCOPE2</i> _{<i>t</i>-1}	0.9978** (2.15)	1.1109*** (3.12)
<i>SCOPE3</i> _{<i>t</i>-1}		0.3187** (2.41)
<i>FIRMSIZE</i> _{<i>t</i>-1}	0.1011*** (6.21)	0.0981*** (5.11)
<i>TURNOVER</i> _{<i>t</i>-1}	-0.1571*** (3.24)	-0.1871*** (4.21)
<i>TOBINSQ</i> _{<i>t</i>-1}	0.1589*** (4.98)	0.1121*** (2.91)
<i>CAPX</i> _{<i>t</i>-1}	3.1210*** (3.97)	2.1047** (2.66)
<i>LEVERAGE</i> _{<i>t</i>-1}	0.1110 (1.46)	0.0027 (0.88)
<i>REP_QUALITY</i> _{<i>t</i>-1}	0.3455*** (3.24)	0.3124*** (3.11)
<i>ESI</i> _{<i>t</i>-1}	-0.2588*** (-4.10)	-0.1121* (-1.79)
<i>EPI</i> _{<i>t</i>-1}	0.0211*** (2.97)	0.0243** (2.12)
<i>CONSTANT</i>	1.3256*** (5.48)	1.4987*** (6.12)
<i>YEAR_FE</i>	Yes	Yes
<i>INDUSTRY_FE</i>	Yes	Yes
<i>COUNTRY_FE</i>	Yes	Yes
F-Stat	18.21***	22.49***
Adj R ²	0.2822	0.3214
N	1088	902

Note: This table reports the estimation of the determinants of TCFD disclosure based on a lead-lag effect regression analysis. Heteroscedasticity-robust standard errors clustered at firm level are shown in parentheses.

*, ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed tests).

committee on firms' likelihood of compliance with CRDs aligned with TCFD recommendations. We observe a positive coefficient (0.2119), statistically significant at the 1% level for *SUS_COMMITTEE*. This implies that companies with a sustainability committee are likely better prepared to comply with CRDs. Essentially, the existence of a sustainability committee enables a company to further its commitment to sustainable outcomes and improve CRDs (Haque 2017; Orazalin and Mahmood 2021; Ricart, Rodríguez, and Sanchez 2005; Zampone et al. 2024). This confirms our second hypothesis, aligning with prior research (e.g., Berthelot and Robert 2011; Gerged et al. 2023; Peters and Romi 2014; Orazalin and Mahmood 2021; Zampone et al. 2024). In Column 2 of Table 5A, with the inclusion of the *SCOPE3* measure, we observe a reduction in the coefficient for *SUS_COMMITTEE* to 0.1999, which remains statistically significant at the 1% level. This outcome reaffirms the critical implications

of GHG emissions across the value chain for reporting entities (Butt et al. 2024). The inclusion of *SCOPE3* highlights the influence that emissions generated throughout the supply chain can have on sustainability governance and the effectiveness of TCFD-aligned disclosures.

In Table 7B, the lead–lag model reports a slightly higher coefficient (0.2477) on $SUS_COMMITTEE_{t-1}$, statistically significant at the 1% level. This demonstrates that firms with a sustainability committee in the prior year tend to have better or improved disclosure in the current year in terms of the degree of their CRDs alignment with TCFD disclosures, and collectively confirms the influence of sustainability committees in achieving high-quality CRDs (Arena, Bozzolan, and Michelin 2015; Liao, Luo, and Tang 2015; Orazalin and Mahmood 2021; Zampone et al. 2024). Theoretically, legitimacy theory posits that sustainability committees allow companies to demonstrate their commitment to sustainable actions, ensuring comprehensive CRD practices (Bui, Moses, and Houqe 2020; Ehalaiye et al. 2024; Ferdous, Rana, and Yeboah 2024). Through compliance with stakeholder theory to meet diverse expectations of various actors (Freeman 1984; Freeman et al. 2010), leading to the establishment of a sustainability committee, companies may have a better chance of readiness for CRD regimes. In this respect, sustainability committees can be a driving force in developing sustainable business practices, assessing stakeholder needs and ensuring the reliability of CRD (Ioannou and Serafeim 2017; Mahmood, Kouser, and Masud 2019; Mallin, Michelin, and Raggi 2013), particularly if the diverse skills and experiences of committee members foster a comprehensive approach to sustainability issues, resulting in better readiness for TCFD-aligned CRDs (Eberhardt-Toth 2017; Liao, Luo, and Tang 2015; Zampone et al. 2024). In Column 2, the inclusion of *SCOPE3* continues to yield qualitatively similar results as observed in the earlier estimations. The findings remain consistent, further reinforcing the robustness of our model and the impact of *SCOPE3* on the overall CRD practices of reporting entities.

In terms of firm-level controls across both models, direct and indirect emission intensities (*SCOPES* 1, 2 and 3), *FIRMSIZE*, *TOBINSQ*, *CAPX*, *LEVERAGE* and *REP_QUALITY* all exhibit positive and statistically significant effects at conventional levels on the likelihood of firms being prepared to disclose TCFD-recommended information (Bui, Moses, and Houqe 2020; Liao, Luo, and Tang 2015). Notably, we observe a marginal level of significance for *AUDIT_COM_INDP* in Column 2 of both models, indicating a limited but present effect on TCFD-recommended disclosures. *TURNOVER* is negatively associated with the TCFD Index and statistically significant at the 1% level. This suggests that firms with lower turnover relative to total assets are more likely to report CRD compliant with TCFD-recommended information, especially when they have a diverse board and a sustainability committee in place. Similarly, *ESI* is negatively associated with TCFD compliance and statistically significant at conventional levels, indicating that firms in environmentally sensitive industries face more uphill tasks in fully adhering to TCFD recommendations. On the other hand, *EPI* is positively associated with TCFD compliance and significant at the 1% level, suggesting that a country's efforts in environmental protection significantly

influence firms' adoption of CRD practices. This is particularly relevant in the absence of a fully enforced mandatory regime, where national environmental policies play a critical role in driving firms towards greater CRDs (Bui, Moses, and Houqe 2020; Liao, Luo, and Tang 2015; Moses et al. 2022).

4.4 | Additional Analyses

4.4.1 | Alternative Sample Specification

We estimate our contemporaneous model across two subsamples: UK firms and Australia/NeZ firms. Table 8 presents the results of this analysis. Across both subsamples, *DIVERSITY* is positive and statistically significant at conventional levels. However, the effect is more pronounced

TABLE 8 | Alternative sample specification.

Variable(s)	UK sample	Australia and NZ sample
	Coeff. (t-value)	Coeff. (t-value)
<i>DIVERSITY</i>	0.5966*** (3.67)	0.4987** (2.29)
<i>SUS_COMMITTEE</i>	0.2689*** (5.12)	0.1988** (2.17)
<i>B_INDP</i>	0.0022 (1.59)	0.0001 (0.89)
<i>AUDIT_COM_INDP</i>	0.0214* (1.83)	0.0011 (1.01)
<i>CEO_DUAL</i>	−0.0089 (−1.22)	−0.0017 (−0.56)
<i>SCOPE1</i>	0.2567*** (3.49)	0.0856** (2.82)
<i>SCOPE2</i>	0.7255** (2.49)	0.6255** (2.01)
<i>SCOPE3</i>	0.3912** (2.11)	0.1148 (1.59)
<i>FIRMSIZE</i>	0.0891*** (5.12)	0.0145* (1.89)
<i>TURNOVER</i>	−0.0811** (−2.29)	−0.1310** (−2.59)
<i>TOBINSQ</i>	0.1498*** (5.11)	0.0195 (1.21)
<i>CAPX</i>	2.1974*** (4.11)	1.1129 (1.06)
<i>LEVERAGE</i>	0.1911* (1.71)	0.0986* (1.77)
<i>REP_QUALITY</i>	0.4122*** (4.01)	0.5968** (2.11)
<i>ESI</i>	−0.2029** (−2.49)	−0.1120*** (−3.11)
<i>EPI</i>	0.0601*** (4.12)	0.0121 (−0.71)
<i>CONSTANT</i>	1.1198*** (4.12)	1.8945** (2.31)
<i>YEAR_FE</i>	Yes	Yes
<i>INDUSTRY_FE</i>	Yes	Yes
<i>COUNTRY_FE</i>	Yes	Yes
F-Stat	27.89***	18.29***
Adj R ²	0.3411	0.3841
N	1024	333

Note: This table reports the estimation of the determinants of TCFD disclosure based on a contemporaneous effect across two sample channels. Heteroscedasticity-robust standard errors clustered at firm level are shown in parentheses. * ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed tests).

among UK firms, with a coefficient of 0.5966***, compared to 0.4987** for Australia and NZ firms. Similarly, we observe a differential for *SUS_COMMITTEE*, which is positive and significant at the 1% level for UK firms (0.2689***), while the effect is lower but still significant at the 5% level for Australia and NZ firms (0.1988**). These results suggest that the influence of board diversity and the presence of a sustainability committee are stronger drivers of CRDs consistent with TCFD recommendations in the United Kingdom compared to Australia and NZ. Overall, our findings from the main model continue to hold across these alternative sub-sample tests, reinforcing the robustness of the results across different geographical contexts.¹⁰

4.4.2 | Endogeneity Test

We conduct our supplementary test based on the Heckman two-stage test to ensure our estimations are consistent as well as mitigate concerns of endogeneity and self-selection bias (Bui, Moses, and Houqe 2020; Ferdous, Rana, and Yeboah 2024; Houqe et al. 2024; Moses, van Zijl, and Houqe 2021). This is important as the selection of firms based on their reporting practices to the CDP can introduce endogeneity, potentially leading to selection bias. Consequently, we employ a two-stage procedure to address the propensity of sampled companies to be chosen from among the firms under examination.

In the initial stage, we use a probit logistic regression to calculate the IMR. To perform this test, we introduce an instrumental variable for Heckman's two-stage test. In line with Zhu, Gao, and Tan (2021), we create a dummy variable *TCFD_DISC* (TCFD dummy) based on firms reporting TCFD-aligned information equal to 1 and 0 otherwise. Firms disclosing TCFD-aligned information are preserved as the treatment group, while those outside the sample served as the control group. Following the methodology of Lennox, Francis, and Wang (2012), we utilise the industry-specific proportion of firms reporting TCFD-aligned information (*P_TCFD_DISC*) and the previous year's decision to disclose TCFD-aligned information (*TCFD_DISC_D_LAG*) to meet exclusion restriction criteria, anticipating a positive correlation. We hypothesise that these variables will meet the exclusion restriction criteria, being linked to TCFD but unrelated to the independent variables. Consequently, the IMR is computed in the first-stage probability model and integrated into the second-stage regression model as an additional explanatory variable to evaluate the presence of a sample selection issue in our main test. For the second-stage regression, we re-estimate the contemporaneous model. We incorporate a transformation of the likelihood of TCFD Index (i.e., *IMR*) derived from the selection model estimated in the first stage as an additional explanatory variable.

In Table 9, Column (1), the results of the first-stage regression reveal that the coefficients for the two exclusion restrictions are both positive and statistically significant, with *P_TCFD_DISC* at 0.8211 ($p < 0.01$) and *TCFD_DISC_D_LAG* at 0.6166 ($p < 0.01$). In the second-stage regression, while the *IMR* itself is not significant at conventional levels, its counter-directional effect suggests that sample selection bias is unlikely to influence the

TABLE 9 | Heckman selection bias test.

Variable(s)	1st stage	2nd stage
	Dep = <i>TCFD_DISC</i>	Dep = <i>TCFD</i>
	Coeff. (t-value)	Coeff. (t-value)
<i>P_TCFD_DISC</i>	0.8211*** (3.61)	
<i>TCFD_DISC_D_LAG</i>	0.6166*** (3.11)	
<i>DIVERSITY</i>	0.3397*** (2.79)	0.6912*** (3.29)
<i>SUS_COMMITTEE</i>	0.4412*** (3.01)	0.2289*** (2.98)
<i>B_INDP</i>	0.0044 (1.40)	0.0088 (1.51)
<i>AUDIT_COM_INDP</i>	0.0229** (2.12)	0.0347** (2.14)
<i>CEO_DUAL</i>	0.0001 (0.69)	0.0001 (0.81)
<i>SCOPE1</i>	0.2011* (1.70)	0.3241*** (4.33)
<i>SCOPE2</i>	0.2011 (0.59)	0.6211*** (5.83)
<i>SCOPE3</i>	0.1120 (1.21)	0.2914** (2.46)
<i>FIRMSIZE</i>	0.1814*** (3.26)	-0.0299 (-1.31)
<i>TURNOVER</i>	-0.0671* (-1.69)	0.0001 (0.41)
<i>TOBINSQ</i>	0.0891** (2.31)	0.1588*** (3.70)
<i>CAPX</i>	-1.2431 (-1.41)	1.5471* (1.82)
<i>LEVERAGE</i>	-0.0910 (-1.11)	0.2199 (0.59)
<i>REP_QUALITY</i>	0.4966** (1.96)	0.7101** (2.41)
<i>ESI</i>	-0.1923** (-1.99)	0.0100* (1.82)
<i>EPI</i>	0.0819*** (2.88)	0.1011*** (3.12)
<i>IMR</i>		-0.9801 (-1.51)
<i>CONSTANT</i>	-1.8966** (-2.42)	4.1289*** (6.12)
<i>YEAR_FE</i>	Yes	Yes
<i>INDUSTRY_FE</i>	Yes	Yes
<i>COUNTRY_FE</i>	Yes	Yes
Pseudo R^2 /Adj R^2	0.1421	0.3121
<i>N</i>	1694	1174

Note: This table reports the estimation of Heckman selection bias of the determinants of TCFD disclosure. Heteroscedasticity-robust standard errors clustered at firm level are shown in parentheses.

* ** and *** represent significance levels of 10%, 5% and 1%, respectively (two-tailed tests).

estimated coefficients of our independent variables (*DIVERSITY* and *SUS_COMMITTEE*), which remain positive and statistically significant at conventional levels (Houqe et al. 2024). Overall, these supplementary results are consistent with the outcomes of our main model, reinforcing the reliability and robustness of our findings.

4.4.3 | Generalised Method of Moments (GMM) Estimation

We conduct a further robustness test using GMM regression analysis, reported in Table 10.¹¹ GMM is used to re-estimate

TABLE 10 | Endogeneity (GMM).

Variable(s)	Coeff. (t-value)
<i>DIVERSITY</i>	0.6188** (2.29)
<i>SUS_COMMITTEE</i>	0.2721*** (3.91)
<i>B_INDP</i>	0.0011 (1.10)
<i>AUDIT_COM_INDP</i>	0.0141 (0.96)
<i>CEO_DUAL</i>	0.0004 (1.57)
<i>SCOPE1</i>	0.2241** (2.18)
<i>SCOPE2</i>	0.7897** (2.44)
<i>SCOPE3</i>	0.2199* (1.74)
<i>FIRMSIZE</i>	0.1711*** (7.10)
<i>TURNOVER</i>	-0.1189*** (-4.77)
<i>TOBINSQ</i>	0.0911*** (-3.84)
<i>CAPX</i>	2.3615*** (4.11)
<i>LEVERAGE</i>	0.2641** (2.49)
<i>REP_QUALITY</i>	0.2341 (1.62)
<i>ESI</i>	-0.3199*** (-5.21)
<i>EPI</i>	-0.1021*** (-3.11)
<i>CONSTANT</i>	1.8985*** (5.11)
<i>YEAR_FE</i>	Yes
<i>INDUSTRY_FE</i>	Yes
<i>COUNTRY_FE</i>	Yes
AR(1)	-19.67***
AR(2)	0.68
Sargantest (df)	7.11
<i>Prob > F</i>	< 0.01
<i>N</i>	1174

Note: This table reports the GMM estimation of TCFD disclosure determinants. Heteroscedasticity-robust standard errors clustered at firm level are shown in parentheses.

*, ** and *** represent significance levels of 10%, 5%, and 1%, respectively (two-tailed tests).

our main model and helps to introduce flexibility in the estimation parameter that addresses issues that may be inadequately accounted for by other tests' parameters (Houqe et al. 2024; Houqe and Khan 2023; Khan, Houqe, and Ielemia 2023). The GMM mitigates issues of endogeneity and effectively addresses inherent estimation concerns associated with heteroskedasticity, serial correlation and potential model misspecification. The outcome of the test aligns with our main conclusion and is qualitatively similar with the results supporting all our hypothesised relations. Specifically, the coefficients on *DIVERSITY* (0.6188) and *SUS_COMMITTEE* (0.2721) continue to be positive and statistically significant at conventional levels.

5 | Conclusion

We assess Australian, New Zealand, and United Kingdom firms' readiness for CRD reporting regime, based on the degree to which their CDP-reported information aligns with TCFD-recommended disclosures, and the CG factors influencing these disclosures. Utilising a uniquely constructed index based on hand-collected data on TCFD-aligned information disclosed to the CDP from 2018 to 2022, our findings reveal substantial alignment of CRDs consistent with TCFD recommendations within the Governance theme, reaching 86%. Risk Management follows with 61% alignment, while Strategy (50%) and Metrics and Targets (49%) show the lowest alignment. We attribute the high thematic alignment in Governance to firms' maturity in integrating governance-related risks into decision-making processes, likely influenced by extensive CG requirements over the past two decades. Furthermore, we observe an inverse trend in aligned disclosures across firm-year observations. While the number of firm-year observations increased from 18% in 2018 to 23% in 2022, overall alignment across the years declined. This suggests that although an increasing number of firms are reporting to the CDP, relatively few firms with prior experience in CRD continue to do so consistently. It is likely that the number of firms reporting their TCFD-aligned information remains relatively stagnant, even as the overall pool of reporting firms to the CDP increases.

Our analysis of CG attributes driving TCFD reporting reveals that board diversity, specifically, the proportion of women on boards, and the presence of a sustainability committee are both positively associated with TCFD disclosures. Firms with a higher percentage of women directors and those with sustainability committees demonstrate greater compliance with TCFD disclosure requirements. The empirical analysis indicates that, on average, firms with approximately 34% women on their boards are likely to have around 42% of TCFD-aligned information already disclosed via CDP reporting. This suggests that companies with a relatively significant representation of women on their boards, particularly when this proportion exceeds the critical mass threshold (Joecks, Pull, and Vetter 2013; Yarram and Adapa 2021), are better positioned to meet the demands of the CRD reporting regime.

This research is distinct in several ways. First, we develop a unique disclosure index based on CDP-TCFD-aligned data, providing a more accurate and comparable basis for cross-sectional analysis. This offers insights into the current state of firms' readiness for evolving CRDs. Second, responding to the call by Ngo et al. (2023), we provide evidence on the role of CG attributes in TCFD-recommended disclosures by demonstrating the influence of gender diversity and sustainability committees in achieving CRD. This represents a departure from previous studies in voluntary settings (e.g., Ben-Amar, Chang, and McIlkenny 2017; Jeanne, Demaria, and Rigot 2023; Liao, Luo, and Tang 2015), particularly in jurisdictions with impending regulation. In this context, we highlight the role of CG attributes in facilitating successful CRDs in countries where regulations are on the horizon. Third, we identify areas requiring urgent attention for firms in these three jurisdictions as they prepare for the forthcoming enforcement of CRD to enhance the competencies needed for extensive reporting.

In contrast to prior studies (e.g., David and Giordano-Spring 2022; Demaria and Rigot 2021; Ehalaiye et al. 2024) that focus on single-country or sector-specific settings, our study employs a cross-country analysis covering Australia, New Zealand and the United Kingdom. This provides incremental knowledge of how CRD practices manifest across different contexts, which is particularly important given the recent sustainability legislation across jurisdictions following the release of IFRS S1 and S2 sustainability standards. Our findings are timely, as the reporting obligations embedded in IFRS S2 are structured around the same four reporting themes of TCFD: Governance, Strategy, Risk Management, and Metrics and Targets (Ehalaiye et al. 2024). Consequently, this provides early guidance on areas requiring close attention as adoption becomes apparent for companies.

Practically, by documenting these insights, we provide organisations with early guidance on the implications of their current CRD practices. This is especially relevant for firms subject to, or soon to be impacted by, mandatory sustainability regulations in their jurisdictions. The findings hold paramount significance for managers, policymakers and regulators. The large proportion of New Zealand firms with aligned TCFD-recommended disclosures suggests that while mandatory CRDs are currently aimed at large financial service organisations, the potential for extension to other sectors appears promising. Additionally, the UK Government is considering a phased-in approach to TCFD-recommended disclosures, with Governance (Phase 1), Risk Management, and Metrics and Targets (Phase 2), and Strategy (Phase 3).¹² However, our results suggest that firms are relatively better positioned to disclose Strategy-related information, while they struggle with Metrics and Targets, which may warrant reconsideration of the phased approach to provide additional provisions for these disclosures. In Australia, as the CRD regime is finalised following the endorsement of TCFD-recommended disclosures, our findings provide Australian firms with insights into how they compare with their counterparts in New Zealand and the United Kingdom in terms of preparedness. This suggests that the imminent regulation is unlikely to impose disproportionate compliance costs or negative consequences. Our findings also call for proactive action from companies likely to be affected by emerging sustainability reporting regulations to strategically develop and implement reporting transition programmes that will help them smoothly comply with the evolving CRD regime.

Despite the incremental value of this study, its findings are limited to three countries and a constrained number of firm-year observations, so caution should be exercised in generalising the results. That said, we believe these findings are crucial to understanding the success of CRD practices across various contexts over time. Further research is necessary to understand the implications of global reporting changes based on larger samples, especially as more data become available. Specifically, as CRD, and particularly TCFD-recommended disclosures, continue to evolve across jurisdictions with uptake in the adoption of the IFRS sustainability standards, further empirical investigation is warranted to examine the effects of mandatory reporting and firms' reporting experiences over time. Additionally, due to the differential progress across the

four TCFD-recommended themes, future research into the relationship between individual themes and firm-specific factors would be invaluable.

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Data Availability Statement

Public data employed in this study are available from appropriate database sources, while the uniquely constructed index data are available from the authors upon reasonable request.

Endnotes

¹ Following the release of its final report on the 2023 status in October 2023, the Task Force on TCFD officially completed its mandate, fulfilling its objectives and subsequently disbanded. In light of this, and with the publication of the ISSB Standards: IFRS S1 and IFRS S2, the FSB requested that the IFRS Foundation take over the role of monitoring the progress of companies' climate-related disclosures from the TCFD. Further details can be found at IFRS Foundation's announcement.

² The CDP, with decades of experience in collecting organisational data on climate change responses, provides avenues to measure, monitor and assess firms' disclosed emission performance and climate-related actions (Jeanne, Demaria, and Rigot 2023).

³ Our use of the term 'sustainability committee' broadly relates to corporate social responsibility (CSR) or environmental committee, and we interchangeably use it in this manner throughout the paper. Specifically, in this study, sustainability committees refer to corporate subcommittees that provide broad sustainability (i.e., social and/or environmental) recommendations to boards, assisting them in sustainability-related decisions (Orazalin 2020; Velte and Stawinoga 2020).

⁴ Our decision to focus on Australia, New Zealand and the United Kingdom is primarily driven by the fact that these countries demonstrate strong and progressive CRD regulations, either already in effect or set to be implemented soon (as discussed earlier). Moreover, firms in these countries are among early global voluntary adopters of CDP and thus offer an opportunity to analyse how such voluntary practices can facilitate a smooth transition into a mandatory environment (Jeanne, Demaria, and Rigot 2023). Second, the accounting practices, as well as regulatory and corporate governance structures in Australia, New Zealand and the United Kingdom are comparable, largely due to their shared English Common Law systems (La Porta et al. 2000, 2002). This common regulatory landscape ensures that observed differences in TCFD-CDP aligned disclosures are more likely attributable to firm-level idiosyncratic governance mechanisms, such as board diversity or the presence of sustainability committees, rather than divergent national policies. Lastly, firms in these jurisdictions operate in highly developed markets with enlightened stakeholders who increasingly demand transparency and accountability in environmental performance and climate risk management (Bui, Moses, and Houque 2020; Ehalaiye et al. 2024; Tsang, Frost, and Cao 2023). Investors, consumers and civil society in these jurisdictions have shown growing concern about corporate sustainability, intensifying the focus on climate-related disclosures. These pressures highlight the importance of corporate governance structures in driving climate-related reporting, positioning Australia, New Zealand and the United Kingdom as critical case studies for understanding global trends in CRD practices.

⁵ 2019 CDP Climate Change Questionnaire.

⁶ We adopt the 2019 CDP Climate Change Questionnaire as the benchmark for our index matching due to its more stable and structured focus on climate-related actions and disclosures, which aligns with the core objective of our empirical assessment and the phenomenon under investigation. While our sampling period commenced in 2018, we specifically mapped and captured only those 2018 disclosures that are consistent with the 2019 CDP Climate Change Questionnaire, ensuring uniformity throughout the sampling period.

⁷ Refer to Appendix A for a comprehensive list of items used in the development of the index.

⁸ $2.9192/4 * 100\%$.

⁹ Coefficient on *DIVERSITY* $0.4213 * 100\%$.

¹⁰ Our additional and subsequent subsample analyses, conducted by individual countries and across the different thematic areas of the TCFD-recommended disclosures (i.e., Governance, Strategy, Risk Management, and Metrics and Targets), do not yield any significant empirical insights and are subsequently abandoned. We attribute this outcome to the limited number of observations within these specific channels.

¹¹ The estimation diagnostics substantiate our initial conclusions. In particular, we observe that all Z-statistics for the Arellano and Bond test (AR(2)) exceed 0.05 in both models, signifying the absence of autocorrelation in the error terms within our models. Similarly, the results from Hansen's tests for overidentification do not offer compelling evidence to reject the hypotheses, affirming the validity of the instruments we employ.

¹² The phased-in approach requires Governance TCFD-recommended disclosures for the 2023–2024 period (Phase 1), Risk Management, and Metrics and Targets disclosures for the 2024–2025 period (Phase 2) and Strategy disclosures for the 2025–2026 period.

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Appendix A: TCFD-CDP Index item list

APPENDIX A | TCFD-CDP Index item list.

TCFD theme	Subcategories	TCFD questions	CDP aligned questions ^a	Index item (N)
Governance (total: nine items)	Board's oversight	GB1: Is the Board informed about climate-related issues?	(C1.1)	1
		GB2: How often the board are informed about climate-related issues?	(C1.1b_C1)	2
		GB3: What are the processes to take climate topics into account in the evaluation and orientation of the strategy (plans, risk managements, policies, budgets, and objectives)?	(C1.1b_C2&C3) two columns (2 and 3) all 8 together	3
		GB4: How does the Board monitor the progress?	(C1.2a)	4
	Management's role	GM1: Has the organisation assigned climate-related responsibilities to management/committees' level positions/structure?	(C1.2_C1)	5
		GM2: How frequently do management/committees level positions with CRO responsibilities report to the board?	(C1.2_C3)	6
		GM3: Do management/committees' level's CRO responsibilities include CRO assessment and management?	(C1.2_C2)	7
		GM4: By which processes are management informed about CRO?	(C2.2b)	8
		GM5: Is a description of the associated organizational structure(s) in describing management's role related to the assessment and management of climate-related issues available?	(C1.1a_C2)	9
Strategy (total: 21 items)	Identification of CRO	SI1: What are the time horizons?	(C2.1_C1&C2)	10
		SI2: What are material climate-related risks?	(C2.3a_C3)	11
		SI3: What are material climate-related opportunities?	(C2.4a_C3)	12
	Impact of CRO	SI1a: How have the identified CRO affected businesses and strategy in Products and services	a: C2.5_:1	13
		SI1b: How have the identified CRO affected businesses and strategy in Supply chain and/or value chain	b: C2.5_:2	14
	Resilience	SI1d: How have the identified CRO affected businesses and strategy in Investment in research and development.	d: C2.5_:4	15
		SI1e: How have the identified CRO affected businesses and strategy in Operations (including types of operations and location of facilities)	e: C2.5_:5	16
		SI2a-1: How have the identified CRO affected financial planning in operating revenues	Rev: C2.6:1	17
		SI2a-2: How have the identified CRO affected financial planning in operating costs	Cost: C2.6:2	18
		SI2b: How have the identified CRO affected financial planning in Capital expenditures and capital allocation	2: C2.6:3	19
		SI2c: How have the identified CRO affected financial planning in Acquisitions or divestments	3: C2.6:4	20
		SI2d: How have the identified CRO affected financial planning in Access to capital	4: C2.6:5	21
	SI2e: How have the identified CRO affected financial planning in Assets	5: C2.6:6	22	
	SI2f: How have the identified CRO affected financial planning in Liabilities	6: C2.6:7	23	

(Continues)

APPENDIX A | (Continued).

TCFD theme	Subcategories	TCFD questions	CDP aligned questions ^a	Index item (N)
		SI2g: How have the identified CRO affected financial planning in others	7: C2.6:8	24
		SI3a Does the organisation use climate-related scenarios to inform the organization's strategy and financial planning?	(C3.1a)	25
		SI3b: What are the scenarios used in organisation's strategy and financial planning?	(C3.1d_C1&C2)	26
		SI4: Does the organisation have emissions reduction initiatives that were active within the reporting year?	(C4.3)	27
		SR1: Are organisation' strategies resilient (2°C or lower scenario)?	(C3.1d): content analysis for Paris or 2 degree	28
		SR2: Explain how climate-related issues are integrated into your business objectives and strategy?	(C3.1c)	29
		SR3: How did companies' strategies change to address potential climate-related risks?	(C2.3a_C15)	30
Risk Management (total: seven items)	Assessment of climate-related risk	RA1: What is the frequency of risk assessment?	(C2.2a)	31
		RA2: What is the risk management process for identifying and assessing the size and scope of climate-related risks? And how do organizations determine the relative significance of climate-related risks in relation to other risks?	(C2.2)	32
		RA3: Has the company considered the existing and emerging regulatory requirements related to climate change (e.g., limits on emissions) as well as other relevant factors?	(C11.1d)	33
		RA4: What relevant factors are considered in climate risk assessment?	(C2.2c_C1)	34
		RA5: Has the company defined climate-related risk terminology? any references to existing risk classification frameworks?	(C4.5a_C4)	35
	Management of climate-related risk	RM2: How are materiality determinations made within their organizations (prioritizing)?	(C2.3a_C14)	36
		Integrated risk assessment	RI1: Has the company integrated climate-related risks assessments into the overall risk management?	(C3.1)
Metrics and Targets (total: 30 items)	Metric	How are related performance metrics incorporated into remuneration policies?	(C1.3a_C1:C4)	38
		MM2: Has the company used internal carbon prices?	(C11.3)	39
		MM3: What percentage of revenue are from products and services designed for a lower-carbon economy?	(C4.5a_C5)	40
		MM4: What methodologies have been used to calculate or estimate climate-related metrics?	(C5.2) (C5.2a)	41
		MM5: Is the verification/assurance status indicated?	C10.1_C1	42
		MM6: Has the company originated or purchased any project-based carbon credits within the reporting period?	C11.2	43
		MM7: Has the company engaged with value chain on climate-related issues?	C12.1	44

(Continues)

TCFD theme	Subcategories	TCFD questions	CDP aligned questions ^a	Index item (N)
	Emissions	ME1: Scope 1	(C6.1)	45
		ME2: Scope 2	(C6.3)	46
		ME3: Scope 3	C6.5_C2	47
		ME4: Has the company provided GHG efficiency ratio?	C6.10_C1	48
		ME5: Is historical emission data available for trend analysis?	(C0.2)_3	49
		ME6: What was the methodology used to estimate the metrics?	(C6.2) + C4.5a_C4 + C6.5_C3	50
	Targets	MT1a: What are the key climate-related targets (GHG emissions-Absolute) for a lower-carbon economy in line with anticipated regulatory requirements or market constraints?	(C4.1a_C3)	51
		MT1b: What are the key climate-related targets (GHG emissions-intensity) for a lower-carbon economy in line with anticipated regulatory requirements or market constraints?	(C4.1b_C3)	52
		MT1c: What are the key climate-related targets (other) for a lower-carbon economy in line with anticipated regulatory requirements or market constraints?	C4.2_C7	53
		MT1d: What are the key climate-related targets (efficiency) for a lower-carbon economy in line with anticipated regulatory requirements or market constraints?	(C4.3b) C_3	54
		MT2: Are the targets absolute or intensity based?	(C4.1)	55
		MT3a: What are the latest deadlines over which the target applies? (absolute emission)	C4.1a_C8	56
		MT3b: What are the latest deadlines over which the target applies? (intensity emission)	C4.1b_C9	57
		MT3c: What are the latest deadlines over which the target applies? (other targets)	C4.2_C6	58
		MT4a: What is the lowest base year from which progress is measured? (absolute)	C4.1a_C5	59
		MT4b: What is the lowest base year from which progress is measured? (Intensity)	C4.1b_C6	60
		MT4c: What is the lowest base year from which progress is measured? (other targets)	C4.2_C4	61
		MT5a: Are the key performance indicators used to assess progress against targets? (energy)	C4.2_C8	62
		MT5b: Are the key performance indicators used to assess progress against targets? (intensity)	C4.1b_C4	63
		MT5c: Are the key performance indicators used to assess progress against targets? (absolute)	C4.1a_C4	64
MT6a: What % of targets is achieved (average)? (absolute)	C4.1a_C10	65		
MT6b: What % of targets is achieved (average)? (intensity)	C4.1b_C11	66		
MT6c: What % of targets is achieved (average)? (energy)	C4.2_C9	67		

Note: The TCFD Index is based on a scoring system, with a score of 1 assigned for each piece of information reported by CDP that aligns with TCFD-recommended items, and a score of 0 otherwise. In total, the TCFD alignment yielded a comprehensive list of 67 items that must be present in a company's CDP-reported information to achieve full alignment with TCFD-recommended disclosures. These 67 items are distributed thematically as follows: 9 items in Governance, 21 in Strategy, 7 in Risk Management and 30 in Metrics and Targets. To ensure relative comparability across these thematic areas, each thematic category score is scaled by the total available items in that category to allow for a proportional score that reflects a company's alignment in that thematic area. This approach provides a foundation for comparative evaluation of a company's alignment in relation to its peers. Subsequently, the proportional scores from the four thematic categories are aggregated for each company to determine its overall TCFD score for a given year. As the maximum thematic proportional score, a company could attain from each category is 1 (indicating 100% alignment with the TCFD template); the maximum total TCFD score across all themes equals to 4.

^aWe adopted the 2019 CDP Climate Change Questionnaire as the benchmark for our index matching due to its more stable and structured focus on climate-related actions and disclosures, which aligns with the core objective of our empirical assessment and the phenomenon under investigation. While our sample selection commenced in 2018, we specifically mapped and captured only those 2018 disclosure practices that were consistent with the 2019 CDP Climate Change Questionnaire, ensuring uniformity throughout the sampling period. Notably, we observed the lowest level of disclosure in 2018 (17.61%), in part due to our stringent criteria that only captured information consistent with the 2019 framework. Additionally, this lower observation can be attributed to the learning curve effect, as firms were still adapting to evolving reporting requirements in subsequent years.

Appendix B: Variable definition

APPENDIX B | Variable definition.

Variable	Label	Description	Source
Task Force on Climate-Related Financial Disclosures Index	<i>TCFD</i>	This is the proportional aggregate score of the four thematic areas of TCFD-recommended disclosures of <i>Governance, Strategy, Risk Management and Metrics & Targets</i> . The maximum score a firm can attain from the proportional aggregate of all the thematic categories is 4, and a minimum of 0.	Constructed by authors based on a uniquely developed CDP_TCFD-aligned template using 67 question items for the period 2018–2022.
Board diversity	<i>DIVERSITY</i>	Percentage of women directors in the board of a firm in year <i>t</i> .	ASSET 42018-22
Sustainability committee	<i>SUS_COMMITTEE</i>	Dummy variables take the value of 1 for if the company has a Sustainability/CRS committee and, otherwise 0 of a firm in year <i>t</i> .	ASSET 42018-22
Board independence	<i>B_INDP</i>	Number of non-executive directors divided by total board size of a firm in year <i>t</i> .	ASSET 42018-22
Audit Committee independence	<i>AUDIT_COM_INDP</i>	Number of non-executive directors in the audit committee divided by audit committee size of a firm in year <i>t</i> .	ASSET 42018-22
CEO duality	<i>CEO_DUAL</i>	Dummy variables take the value of 1 for if the company's chairman and CEO is the similar individual and, otherwise 0 of a firm in year <i>t</i> .	ASSET 4 2018-22
Direct emission intensity	<i>SCOPE1</i>	Total scope 1 emissions scaled by sales of a firm in year <i>t</i> .	ASSET 4 2018-22
Indirect emission intensity	<i>SCOPE2</i>	Total scope 2 emissions scaled by sales of a firm in year <i>t</i> .	ASSET 4 2018-22
Indirect emission intensity	<i>SCOPE3</i>	Total scope 3 emissions scaled by sales of a firm in year <i>t</i> .	ASSET 4 2018-22
Firm size	<i>FIRMSIZE</i>	The natural logarithm of firms' total sales in year <i>t</i> .	ASSET 4 2018-22
Asset turnover	<i>TURNOVER</i>	Total sales divided by total assets of the in-year <i>t</i> .	ASSET 4 2018-22
Leverage	<i>LEVERAGE</i>	Total long-term debt divided by total assets	ASSET 4 2018-22
TOBINSQ	<i>TOBINSQ</i>	The sum of the market value of equity plus the book value of total debt scaled by total assets.	ASSET 4 2018-22
Capital expenditure	<i>CAPX</i>	Total capital expenditure divided by total assets a firm in year <i>t</i> .	ASSET 4 2018-22
Reporting Quality	<i>REP_QUALITY</i>	Natural logarithm of one plus number of analysts following the firm in year <i>t</i> .	ASSET 4 2018-22
Environmental sensitive industry	<i>ESI</i>	Environmental sensitive industry: If the firm belongs to any one of five environmentally sensitive industries (two-digit SIC codes of 13, 26, 28, 29, 33) equal to 1, otherwise 0, in year <i>t</i> .	ASSET 4 2018-22
Environmental performance index	<i>EPI</i>	Country-level environmental performance index.	Yale Center for Environmental Law and Policy in collaboration with the World Economic Forum. See https://epi.envirocenter.yale.edu/
TCFD disclosure	<i>TCFD_DISC</i>	Firms reporting TCFD information equal to one and zero otherwise	ASSET 4 2018-22
Proportion of TCFD disclosure in a specific industry	<i>P_TCFD_DISC</i>	Industry-specific proportion of firms reporting TCFD information	ASSET 4 2018-22

(Continues)

APPENDIX B | (Continued).

Variable	Label	Description	Source
Lag TCFD disclosure	<i>TCFD_ DISC_D_LAG</i>	Previous year's decision to disclose TCFD information	ASSET 4 2018-22
Inverse Mill Ratio	<i>IMR</i>	Inverse Mill Ratio—transformation of the likelihood of TCFD derived from the selection model estimated in the first stage, as an additional explanatory variable to mitigate concerns of endogeneity and self-selection bias.	
Year effects	<i>YEAR_FE</i>	A vector of dummy variables indicating year	ASSET 4 2018-22
Industry effects	<i>INDUSTRY_FE</i>	A vector of dummy variables indicating industry	ASSET 4 2018-22