Board Gender Diversity and Climate Risk Disclosure*

Abhinav Anand† Jalaj Pathak‡ Arun Upadhyay§ Chi Zhang¶

Abstract

We investigate the impact of women's representation in corporate boards on firms' climate risk disclosure. We use textual analysis and exploit the passage of the California Senate Bill mandating women's representation in boards to show that firms with higher female board representation provide significantly more concise and more readable climate risk disclosures in their regulatory filings. Cross-sectional tests reveal that the impact is especially strong for firms with an ESG committee and for those that are more exposed to climate-related risks. We rule out the possibility that this reduction is due to information-withholding or greenwashing and demonstrate that it is driven by superior environmental performance which in turn, significantly lowers the need for elaborate climate-related disclosure in the first place. Overall, our findings illuminate the pivotal role of board gender diversity in alleviating climate risk concerns.

Keywords: Board Gender Diversity; Climate Disclosure; Risk Factor; Textual Analysis

JEL Classification: G14, G34, M41

*We thank participants at the Sydney Banking and Finance Stability Conference (2024), India Management Research Conference (2024), seminar audience at the Florida International University, University of Massachusets Lowell and Siyang Tian for helpful comments. Author names appear in lexicographic order.

†Indian Institute of Management Kozhikode; Email: abhinav.anand@iimk.ac.in

‡Indian Institute of Management Lucknow; Email: jalaj.pathak@iiml.ac.in

§Florida International University; Email: arupadhy@fiu.edu

¶Manning School of Business, University of Massachusetts Lowell; Email: Chi_Zhang1@uml.edu

1 Introduction

There is increasing demand from investors for more detailed and reliable information on climate risks which in turn, has compelled firms to provide more comprehensive climate risk disclosures (Cohen et al., 2023; Matsumura et al., 2024).[1] By being transparent about climate-related risks, companies can enhance their legitimacy in the eyes of stakeholders (Huynh and Xia, 2021; Krueger et al., 2021; Ramadorai and Zeni, 2024) and signal strong performance to investors (Clarkson et al., 2008; Boulland et al., 2019; Bourveau et al., 2024; Christensen et al., 2024). In contrast, more disclosure need not necessarily be more informative, especially if it features prolix language inserted merely to comply with regulations. These competing views are reflected in prior studies which have shown that mandating ESG disclosure can lead to externalities in the ESG domain (Jiang et al., 2023).[2]

In this study, we ask the following question: Does gender diversity in corporate boardrooms influence how firms manage and communicate climate-related risks? This question sits at the intersection of two defining challenges facing modern corporations: environmental sustainability and board representation. While a growing body of research documents that female directors approach risk differently than their male counterparts, we know surprisingly little about whether and how their increased representation in corporate boards shape firms' environmental risk management and disclosure practices.

On the one hand, gender diversity in boards may reduce the volume of climate-related disclosures. Women directors, known for their cautious and risk-averse approach (Barber and Odean, 2001; Adams and Ferreira, 2009; Huang and Kisgen, 2013) often implement stringent environmental practices to manage climate-related risks effectively, which can diminish the need for frequent disclosures. Their strong focus on ESG and environmental sustainability leads them to address climate issues proactively, aligning with a long-term orientation toward these challenges (Krueger et al., 2021). Consequently, gender-diverse boards may prioritize climate

[1] Regulatory frameworks such as the European Union's Non-Financial Reporting Directive (NFRD) and the Task Force on Climate-related Financial Disclosures (TCFD) recommendations have significantly influenced corporate climate risk disclosure practices (Bebbington and Larrinaga, 2014; Carney, 2015).

[2] Ilhan et al. (2023), Moss et al. (2024) and Flammer et al. (2021) also present the impact of shareholding pattern and shareholding activism on climate disclosure respectively.

mitigation efforts from the outset, reducing the necessity for extensive climate risk disclosures.

One the other hand, the presence of women on boards is often associated with greater transparency and accountability, leading to increased climate-related disclosures. Companies with female directors tend to be more open about climate practices and risks due to the diverse perspectives women bring, which emphasize stakeholder orientation (Adams and Ferreira, 2009). Women directors' heightened risk awareness also encourages thorough climate risk assessments and disclosures (Wahid, 2019; Edmans et al., 2023). This focus on transparency promotes a culture of openness, ensuring that stakeholders are informed about the impact of climate change on the company.

In other words, the relation between board gender diversity and climate risk disclosure is not clear a priori. To tackle this empirical question, we extract the climate-related text from the Risk Factor section in US firms' 10-K during 2005–2021. We find that a unit standard deviation increase in female board representation (10.7 percentage points) is associated with approximately a 5.1 percentage point decrease in climate-related discussions in firms' Risk Factor disclosures. To address endogeneity concerns, we exploit the passage of the 2018 California Senate Bill (No. 826) which mandated California-headquartered corporations to include at least one female director on their board by December 31, 2019.[3] We employ a difference-in-differences framework to add a causal dimension to our baseline results and show that the passage of the bill led to a significant reduction in the volume of climate risk disclosures of firms that raised the number of women in their boards. Additional cross-sectional analyses reveal that the impact is intensified for firms which have an ESG committee and those which are especially exposed to climate risks.

In principle, our results could also be explained by strategic information-withholding in disclosures. However, we rule out this alternative by showing that more gender diversified boards significantly improve readability and reduce the negativity (in tone) of climate risk disclosures. If female directors were strate-

[3]Furthermore, it mandated at least two women directors if a board had five directors and three women directors if the board had six or more directors by December 31, 2021 (Greene et al., 2020).

gically concealing climate-related risks, one would expect to observe either no change or a worsening of the readability and amplification of negativity in the tone to deflect scrutiny.[4] Instead, the significantly improved readability and less negative tone suggests that firms with greater female board representation may have better-managed climate risks which in turn reduces the need for elaborate disclosures in the first place.

To buttress our arguments, we employ topic modeling ising Latent Diriclet Analysis (LDA) (Blei et al., 2003) to identify the specific dimensions in which climate issues are no longer discussed. In addition, we gather firms' environment ratings from the KLD database and Greenhouse Gas (GHG) emissions data from Trucost. We demonstrate that firms with more gender diversified board display superior environmental performance through better management of climate-related matters in finance and operation, improved environmental ratings, and reduced emissions. These findings bolster our claim that the reduction in climate risk disclosure in the presence of more women board members reflects better environmental risk management rather than strategically prompted information-withholding and/or greenwashing. Finally, our two-stage least squares analysis reveals that more efficient climate risk disclosure—as instrumented by board gender diversity—is associated with higher firm value.

Our paper makes several contributions to the literature. First, we go beyond traditional metrics by examining how board gender diversity affects not only the volume but also the quality of climate-related disclosures in the Risk Factor section of 10-K filings. By assessing readability and tone, our study adds a nuanced view, showing that gender-diverse boards produce more accessible and less negative climate disclosures, potentially enhancing transparency and stakeholder trust. Unlike most studies that assess overall climate or ESG disclosures, our study specifically targets the Risk Factor section of 10-K reports, which is highly relevant to investors seeking information on potential risks (Campbell et al., 2014; Hope et al., 2016; Brown et al., 2018; Huang et al., 2022a). This focus aligns the findings with the interests of investors and regulators by evaluating disclosures in

[4]This is because the tone of the Risk Factor section is quite negative to begin with since it describes all sources of material risks and adverse scenarios without the discussion of any mitigating or offsetting policies or circumstances (Campbell et al., 2014).

a section that is directly related to risk assessment.

Second, we examine the mechanisms through which a gender-diverse board influences a firm's climate risk management policies, thereby making significant contributions to the literature on Environmental, Social, and Governance (ESG) practices. By demonstrating that gender-diverse boards are linked to better-managed climate risks, which result in more effective and efficient disclosures, our study highlights how diversity aligns with sustainable governance practices (Adams and Ferreira, 2009). Additionally, we highlight that gender diversity's influence is especially pronounced in firms with dedicated ESG committees, providing empirical evidence that such boards are more proactive and strategic in addressing climate-related risks (Eccles et al., 2014; Ferrell et al., 2016). This nuance contributes to the ESG discourse by showcasing how board composition can drive substantial improvements in climate accountability and environmental performance, suggesting that diversity is a pivotal component of sustainable corporate governance.

Finally, our paper contributes to the literature on the real effects of boardroom diversity. Griffin et al. (2021), An et al. (2021) highlight the positive effects of board gender diversity on corporate innovation, consistent with evidence showing that companies with women directors tend to be more transparent and prioritize stakeholder orientation over shareholder orientation (Adams and Ferreira, 2009; Upadhyay and Zeng, 2014; Nadeem, 2022). Our findings align with this body of literature, providing additional evidence of the positive impact that achieving gender diversity in corporate boardrooms may be an important mechanism for promoting both effective environmental risk management and efficient risk communication in financial markets.

The paper is organized as follows. Section 2 discussed the literature and hypothesis and 3 presents the data and methodology used in this study. Section 4 presents the baseline results for the impact of gender diversity on climate risk disclosure, robustness checks, results from the exogenous shock by the passage of the California Senate Bill, as well as cross-sectional results. Section 5 provides additional results which examine potential channels via which board gender diversity impacts climate-related corporate disclosures. Finally, section 6 concludes.

2 Hypothesis Development

We posit that, the board gender diversity can reduce the volume of climate-related disclosures for the following reasons. First, women directors' cautious and risk-averse nature (Barber and Odean, 2001; Adams and Ferreira, 2009; Huang and Kisgen, 2013) and intense disutility from negative outcomes (Croson and Gneezy, 2009) can lead to better management of climate-related risks and implement stringent environmental practices and policies. This pre-emptive approach to risk management can significantly lower the frequency and severity of climate-related incidents, making extensive disclosures less necessary. Second, women board members' strong emphasis on ESG often results in a greater focus on environmental sustainability (Bear et al., 2010). Women directors are likely to prioritize the mitigation of climate issues from the outset, thereby reducing the need for extensive climate risk disclosures (Croson and Gneezy, 2009; Huang and Kisgen, 2013). That is consistent with the belief that more gender diverse boards may be more long-term orientation (Griffin et al., 2021), while climate issues tend to be long-term in nature (Krueger et al., 2021).

H1a: There is a negative association between board gender diversity and the volume of climate-related risk disclosures.

Conversely, the presence of women board members often correlates with greater transparency and accountability (Gull et al., 2018), leading to increased climate disclosures. Studies suggest that companies with women directors are more inclined to be transparent about their climate-related practices and risks (Upadhyay and Zeng, 2014; Nadeem, 2022). This transparency is driven by the diverse perspectives that women bring to the board, which often prioritize stakeholder orientation over shareholder orientation (Adams and Ferreira, 2009). Additionally, women board members tend to have a heightened awareness of risks, prompting them to advocate for more comprehensive climate risk assessments and disclosures (Wahid, 2019; Edmans et al., 2023). This could result in more detailed reporting on how climate change impacts the company's operations and financial performance, which results in the integration of climate risks into financial reports ensures that

all stakeholders are well-informed about the potential impacts of climate change. Based on the above discussion, one can expect that more female board members could positively impact transparency that manifests in more climate-related discussion in firms' disclosures. We present the competing hypothesis as below:

H1b: There is a positive association between board gender diversity and the volume of climate-related risk disclosures.

3 Data, Sample Selection, and Key Variable Construction

We begin by downloading the 10-K files for all US firms within the time period 2005-2021 from the SEC website.[5] The reason for beginning the sample in 2005 is due to the fact that the SEC mandated the inclusion of the Risk Factor section from this year onwards (Huang et al., 2022b). We exclude firms in our sample which have missing data on their security prices or on key accounting variables in CRSP and Compustat. We further require each firm-year to have available information from the Institutional Shareholder Services (ISS) so that we are able to extract board and other corporate governance-related variables. Our final analytical sample consists of 16,447 firm-year observations. Table 1 provides detailed information of our sample creation process.

[Table 1 about here.]

To assess firms' climate-related disclosure, we extract and textually analyze the 'Risk Factor' (RF) section (Section 1A) for every downloaded 10-K file (Campbell et al., 2014; Hope et al., 2016). We first break down the RF section into a collection of sentences and then distinguish climate-related sentences from others by identifying climate-related words/phrases ('ngrams'),[6] which capture the presence

[5] https://www.sec.gov/edgar/search/.

[6] n refers to the number of words/phrases e.g., "climate change" and "carbon emission" are 2 grams (bigrams).

of climate-related discussion in each sentence.[7] From the perspective of text analytics, the approach of using sentences and ngrams works better (Andreevskaia and Bergler, 2008) as compared to a unigram bag-of-words approach (Loughran and McDonald, 2011).[8] The list of terms and phrases which are used to identify climate-related discussion is taken from two major sources: i) the United States Environmental Protection Agency (`https://www.epa.gov`), and ii) Wordstream (`https://www.wordstream.com`). Each sentence that contains at least one such climate-related ngram is categorized as a climate-related sentence. For each firm-year, we identify such climate-related sentences and collect them together to form the "climate text" of the Risk Factor section.[9] We define the firm variable "*Climate Risk Disclosure*" [CRD] as the percentage of sentences that contain at least one climate-related word or phrase in the Risk Factor section of its 10-K.

Our key dependent variable, '*Climate Risk Disclosure*' (CRD), shows considerable variation across firms. The mean (median) percentage of climate-related discussion in risk factor disclosures is 1.73% (1.14%), with a standard deviation of 1.77% and maximum value of 16.33% suggesting significant heterogeneity in firms' climate-related disclosures.

Our key independent variable, *Board Gender Diversity*, is the percentage of women directors. Following prior literature (e.g., Balsam et al., 2021), we include a vector of control variables in the model as follows: percentage of independent directors (*'Indp Board %'*), log of the number of directors (*'Log(Board Size)'*), size (*'Log(Assets)'*), *'Leverage'*, R&D expenses divided by total assets (*'R&D/Assets'*), capital expenditure ratio (*'Capex/Assets'*), net property, plant, and equipment divided by total assets (*'PPENT/Assets'*), and *Business Complexity* (number of segments).

Table 2 presents summary statistics for our sample of 16,447 firm-year observations spanning 2005–2021. Panel A reports that women constitute, on average, 15.94% of board membership, with a median of 15.38% and substantial variation across firms (standard deviation of 10.73%). The percentage of women directors ranges from 0% to 37.50%, indicating significant heterogeneity in board gender di-

[7] The full list of such words used in our study is presented in Appendix A.

[8] In our study, we consider unigrams and bigrams ($n = \{1, 2\}$).

[9] Appendix B presents some examples which illustrate instances of Climate Risk Disclosure in the Risk Factor section of the 10-K.

versity across our sample. Independent directors comprise a considerable portion of boards, with a mean (median) of 79.36% (81.81%), suggesting strong governance mechanisms in our sample firms.

[Table 2 about here.]

The average board size (in natural logarithm) is 2.22 ($\approx$ 9 directors), while the average firm size is \$3.7 billion (based on antilog value of assets). Sample firms maintain moderate leverage ratios, with a mean (median) of 0.19 (0.15). Average R&D and capital expenditure intensities are relatively low, with means of 2% and 4% of total assets, respectively. The high mean value of PPENT (0.80) indicates significant tangible asset bases across sample firms. Our control variables seem to be comparable to the prior literature.

Panel B reveals an interesting temporal pattern in climate risk disclosures. The number of firm-year observations is evenly spread across each year between 750 and 1,100. The intensity of climate-related discussions peaked in 2006 (mean of 2.56%) and has generally declined over time, with notable drops in 2018–2019 (means below 1%) before a slight uptick in 2020–2021. This pattern may reflect evolving regulatory requirements and changing corporate attitudes toward climate risk disclosure.

Panel C demonstrates substantial cross-industry variation in climate risk disclosure practices. Energy and Utilities sectors exhibit the highest intensity of climate discussion (means of 3.97% and 2.85%, respectively), consistent with their greater exposure to climate-related risks. In contrast, Telecom and Healthcare sectors show minimal climate risk disclosure (means of 0.31% and 0.56%, respectively). This variation suggests that industry-specific factors significantly influence firms' climate risk disclosure practices.

4 Empirical Results

4.1 Baseline Results

To gauge the association between board gender diversity and firms' Climate Risk Disclosures, we estimate Equation (1) as follows.

$$\textit{Climate Risk Disclosure}_{i,t+1} = d_0 + d_1 \times \textit{Board Gender Diversity}_{i,t} + \sum_j d_j \times \mathrm{X}^j_{i,t} + \theta_t + \theta_{ind} + \theta_s + u_{i,t} \quad (1)$$

The dependent variable '*Climate Risk Disclosure*' is the percentage of sentences in the Risk Factor Section (1A) that contain at least one climate related word/phrase. Our key independent variable, '*Board Gender Diversity*', is the percentage of women directors on the board. As remarked earlier, we follow prior literature (Balsam et al., 2021) to include the following control variables. X represents the vector of control variables: percentage of independent directors, log of the number of directors, size, leverage, R&D ratio, capital expenditure ratio, net property, plant, and equipment ratio and a dummy for business complexity. We include year fixed effects (θ_t) to control for market-wide shocks, industry fixed effects (θ_{ind}) to control for industry-wide time-invariant characteristics, and state fixed effects (θ_s) for location-specific time-invariant characteristics. The standard errors are clustered at firm level.

Table 3 presents our baseline results. Across all specifications, we find a negative and statistically significant relationship between the percentage of women directors (*Board Gender Diversity*) and firms' climate risk disclosure. The economic magnitude of this effect is substantial: in our most conservative specification with year, industry and state fixed effects (column (3)), a unit standard deviation increase in women's board representation (= 10.73 percentage points) corresponds to approximately a 5.1 percentage point decrease in climate-related discussions in firms' Risk Factor disclosures (-0.475 × 10.73 = -5.1).

[Table 3 about here.]

The control variables generally display expected signs. The size of the firm

(*Log(Assets)*) shows a positive and significant relationship with climate risk disclosure across all specifications, consistent with larger firms facing greater stakeholder pressure for environmental transparency. We find that *R&D* intensity and net property, plant and equipment (*PPENT*) have significant negative association with climate risk disclosure, with coefficients of -0.826 and -1.124 respectively in our fully specified model (both significant at the 1% level). This indicates that firms with greater investment in innovation and fixed assets may face lower climate-related risks or could have better systems in place to manage such risks.

The adjusted R-squared increases substantially from 0.196 to 0.315 as we add fixed effects, indicating that industry, year, and state-level factors explain considerable variation in firms' climate risk disclosure practices. The stability of our key coefficient on *Board Gender Diversity* across specifications with progressively more stringent fixed effects helps address concerns about omitted variables and provides support for a robust relationship between board gender diversity and climate risk disclosure practices.

There findings are supportive of H1a and consistent with the notion that women directors in generally take more proactive approach to environmental risk management, potentially reducing the need of extensive climate risk disclosure. To further validate this interpretation and rule out alternative explanations, we conduct additional analyses examining the mechanisms in subsequent sections.

4.2 Robustness Checks

To ensure the robustness of our baseline results, we conduct a battery of tests. First, instead of using the percentage of women directors to capture board gender diversity, we define a binary variable, *Board Gender Diversity Dummy*, which takes the value of 1 if there is at least one female board member, and zero otherwise. We report results in column (1) of Table D1 in Appendix D. Second, in column (2), instead of examining the volume of climate-related text expressed as a percentage, we define the *Climate Risk Disclosure Dummy* as a binary variable which takes the value of 1 if there is some climate risk disclosure in the Risk Factor section, and zero otherwise. In column (3), we employ the Logit model with controls and industry, year and state fixed effects and confirm that our benchmark results

continue to remain robust.

We further demonstrate the robustness of our results by conducting the following tests. In Table D2 instead of clustering standard errors at the firm-level, we resort to clustering at the state-level. In Table D3 we include additional control variables which measure institutional ownership of the firm. Further, in Table D4, we restrict our sample to be in the interval 2010–2021 in light of the 2010 SEC interpretive guidance which states that companies are expected to disclose climate risks that can materially affect registrants' business operations and financial performance (Securities and Exchange Commission, 2010). Finally, in Table D5 we look at climate risk disclosure in other relevant sections of the 10-K (as opposed to only the Risk Factor section) such as the 'Management Discussion & Analysis (MD&A)' (Section 7) and 'Business Description' (Section 1) (Securities and Exchange Commission, 2010; Matsumura et al., 2024). We continue to observe—in all such tests and specifications—the significant negative relationship between board gender diversity in corporate boards and the level of climate risk disclosure in firms' 10-K.

4.3 Alleviating Endogeneity Concerns: Passage of the California Senate Bill

While we find a robust negative association between the presence of women directors and a firm's climate risk disclosures, it could still be the case that this association is driven by the endogeneous matching of high-quality firms that happen to prefer to have a more gender diverse board as well as more environmentally friendly policies.

Therefore, to circumvent such objections and to inject causality in our inferences, we exploit a quasi-natural experiment: passage of the California Senate Bill No. 826 (SB 826) in 2018 that required publicly traded corporations headquartered in the state of California to include at least one woman on their boards by the end of 2019.[10] We treat the passage of this law as an exogenous change in the landscape of women's representation in corporate boards. It compelled

[10]The law also mandated that, by the end of July 2021, at least two women must sit on boards with five members, and at least three women must sit on those with six or more members.

all firms headquartered in California to comply by mandating an increase in the number of women directors among those firms with two or fewer women on their boards.[11] The law essentially required that firms with 4, 5, and 6 or more board members needed to have a minimum 1, 2, and 3 women directors in their boards, respectively.

To alleviate the concern that the treated firms might be fundamentally different from the control firms across observable major characteristics, we employ the propensity score matching technique and select control firms that are largely similar to the treated firms. We begin by retaining all observations for treated and control firms in 2018. We then estimate a logistic regression, where the dependent variable is an indicator variable that equals one if the firm is a treated firm, and zero otherwise. In this model, we include the same vector of control variables as in the baseline model. We then match each treated firm to one control firm (without replacement) with the closest propensity score, which results in 1,093 unique matched pairs. In Table 4 Panel A, we report the estimation results of the pre-match regression and the post-match diagnostic regression. While in column (1) there are statistically significant differences between pre-matched firms, we find that in column (2) most of the coefficient estimates of the control variables become insignificant after being matched, and the pseudo R-square shrinks from 0.126 to 0.001. These results indicate that our matching procedure is well executed.

[Table 4 about here.]

In Panel B, we report the sample means of the control variables for the matched treated and control firms corresponding to year 2018. Such a comparison reinforces the assertion that the observable characteristics between the selected treated and control firms are largely indistinguishable after matching.

Most importantly, in Table 4 Panel C, we estimate the following model based on the matched sample, which consists of all observations of the 1,093 unique matched pairs. In particular, we attempt the standard difference-in-differences specification in Equation (2) below, with the dummy variable *Post* taking value 1 after 2019 and zero otherwise, and the dummy variable *Treated* assuming value 1

[11] Greene et al. (2020) features detailed discussions regarding this bill.

for the set of firms required to add more women directors to their board per the California law.

$$\begin{aligned} \textit{Climate Risk Disclosure}_{i,t+1} =& d_0 + d_1\, \textit{Treated}_i \times \textit{Post}_t + d_2 \times \textit{Post}_t \\ &+ d_3 \times \textit{Treated}_i + \sum_j d_j \times X^j_{i,t} \\ &+ \theta_t + \theta_{ind} + \theta_s + u_{i,t} \end{aligned} \tag{2}$$

Importantly, we observe significantly negative coefficient estimates on *Treated*×*Post*, reinforcing our baseline findings that firms tend to disclose less about climate risks in their 10-K reports following increases in the number of women directors. This result adds a causal dimension to our benchmark findings.

4.4 Cross-Sectional Analysis

In this section, we examine how would the documented negative relation between board gender diversity and climate risk disclosures vary in the cross section. For example, the SEC reported that the impact of Climate Change Risk (CCR) was more pronounced for firms with more climate-sensitive businesses and those facing more pressure from external stakeholders (Shorter, 2013). Similar cross-sectional variation is observed in the impact of women in board with respect to firm risk (Kim et al., 2023) and performance (Owen and Temesvary, 2018).

Motivated by prior literature, we examine three major cross-sectional characteristics: i) presence of an ESG committee, ii) climate exposure of the firm, and iii) directors' age. We introduce the variable *ESG Committee* which takes the value 1 if there is a committee that is ESG-related and 0 otherwise. We define a committee to be ESG-related if it has the words "Environment", "Environmental", "Social", or "Governance" in its name. On similar lines, we define a dummy which takes the value 1 for firms whose climate exposure is higher than the median in a financial year (Sautner et al., 2023) and *Directors' Age Dummy* which takes value 1 when the median age of directors in a firm is higher than the median for all firms in that year.

Our results are reported in Table 5. First, columns (1) and (2) show that the negative relationship between *Board Gender Diversity* and *Climate Risk Dis-*

closure is significantly stronger for firms with dedicated ESG committees. The interaction coefficient of -1.268 (significant at 5%) in our fully specified model suggests that the presence of an ESG committee nearly triples the baseline effect. This finding suggests that female directors may be particularly effective at managing climate-related risks when supported by formal ESG governance structures. Second, we find that the impact is amplified in firms with higher climate exposure (columns (3) and (4)). The interaction term between *Board Gender Diversity* and *Climate Exposure Dummy* is negative and significant (-0.887, p <0.01), indicating that female directors' influence on climate risk disclosure is particularly pronounced in firms facing greater climate-related challenges. This result supports the interpretation that female directors take a more proactive approach to environmental risk management in contexts where such risks are more salient. Finally, columns (5) and (6) demonstrate that board age composition significantly influences the relationship of interest. The negative interaction coefficient with the *Directors' Age Dummy* (-0.672, p <0.01) indicates that the impact of *Board Gender Diversity* is stronger in firms with older boards. This could reflect generational differences in approaches to risk management and disclosure, or the enhanced effectiveness of female directors in more experienced boards.

[Table 5 about here.]

Collectively, our cross-sectional analysis provide important nuance to our baseline findings. The varying magnitude and significance of the effect across different firm characteristics suggests that the influence of board gender diversity on climate risk disclosure operates through multiple channels and is contingent on firms' governance structures, risk exposure, and board characteristics. These findings have important implications for understanding how board composition interacts with other governance mechanisms to shape firms' environmental risk management and disclosure practices.

5 Additional Analyses

5.1 Do Female Directors Strategically Withhold Information?

So far, the evidence presented suggests that increases in the number of women directors reduces climate risk disclosures. One explanation could be that women directors tend to withhold information, and the reduction in climate risk disclosure is a manifestation of this tendency. To investigate those criticism, we run two additional tests by textually analyzing the readability and the tone of *Climate Risk Disclosure* in the Risk Factor section of 10-K. We conduct such tests since several relevant studies have pointed out that information-withholding is associated with text which is lengthy and suffers from poor readability and managers could exploit it to hide or obfuscate relevant information (Bloomfield, 2008; Loughran and McDonald, 2011, 2014a,b; Rogers et al., 2014).

We compute the readability of *Climate Risk Disclosure* in the Risk Factor section of 10-K by using the Fog Index (Gunning, 1952). This measure of readability has been widely used in a range of accounting and finance studies (Li, 2008; Loughran and McDonald, 2015). The Fog Index has two components: i) average words per sentences, and ii) percentage of complex words (words more than two syllables). The Fog Index is simply a linear combination of both these components.[12] Thus, a higher Fog Index score implies a more difficult to read text.

Furthermore, we quantify the tone of the *Climate Risk Disclosure* using the dictionary specified as per Loughran and McDonald (2011) which characterizes financial terms as positive (+1), negative (-1) or neutral (0) (e.g., 'profit' is positive, 'loss' is negative etc.) to arrive at an aggregate tone for the whole climate-related text in the firms' disclosure document.

We employ the specification below to gauge the impact of gender diversity on the readability and tonality ('*CRD Characteristics*') of a firm's climate risk

[12] $0.4 \times$ [Average Words Per Sentence + Percentage of Complex Words]

disclosure (CRD):

$$\begin{aligned} \textit{CRD Characteristics}_{i,t+1} =& d_0 + d_1 \textit{Board Gender Diversity}_{i,t} + \\ & \sum_j d_j \times \mathrm{X}_{i,t}^j + \theta_t + \theta_{ind} + \theta_s + u_{i,t} \end{aligned} \tag{3}$$

The results presented in Table 6 strongly reject the information withholding hypothesis. Across both specifications (columns (1) and (2)) we find that higher female board representation is associated with significantly more readable climate risk disclosures. In our most conservative specification with full fixed effects (column (2)), the coefficient on *Board Gender Diversity* is -11.797 (significant at the 1% level). The economic magnitude is substantially higher than that of our benchmark result. This represents a significant improvement in readability, as lower Fog Index values indicate more accessible text.

[Table 6 about here]

This finding is particularly important because if female directors were strategically withholding information, we would expect to observe the opposite pattern: more complex, obscure language that makes it harder for investors to assess climate-related risks. Instead, the negative relationship between *board gender diversity* and Fog Index suggests that female directors promote more transparent, accessible climate risk disclosures. This interpretation is strengthened by prior literature showing that managers attempting to conceal or withhold information typically do so by making disclosures more complex and less readable (Bloomfield, 2008). This finding also aligns with Nadeem (2021), which presents a significantly positive impact of board gender diversity on the readability of the 10-K.

Table 7 provides additional evidence that helps evaluate the information withholding hypothesis by examining the relationship between board gender diversity and the tone of climate risk disclosures. The results further contradict the information withholding interpretation of our earlier findings. In both specifications (columns (1) and (2)) we find that higher participation of women in corporate boards corresponds to significantly less negative tone in the Risk Factor section. The coefficient on *Board Gender Diversity* is positive and statistically significant (0.059, p <0.10 in our most conservative specification with full fixed effects). Given

that the Risk Factor section of 10-K filings is traditionally characterized by negative language focused on potential risks and adverse scenarios (Campbell et al., 2014) this finding is particularly noteworthy.

[Table 7 about here]

These results argue against the information withholding hypothesis for several reasons. First, if female directors were strategically concealing climate-related risks, we would expect to observe either no change in tone or potentially even more negative tone to deflect scrutiny. Instead, the significantly less negative tone suggests that firms with more gender diversified board may actually have better-managed climate risks to report. Second, the literature on strategic disclosure suggests that managers attempting to withhold or obscure negative information often resort to more negative language to create a "kitchen sink" effect or to pre-empt criticism (Rogers et al., 2014). The more positive tone we observe is inconsistent with such behavior.

Together, these findings suggest that the reduced volume of climate risk disclosure associated with female board representation likely reflects better environmental risk management rather than strategic information withholding. This interpretation aligns with prior literature documenting female directors' more proactive approach to risk management (Adams and Ferreira, 2009) and greater attention to stakeholder interests (Bear et al., 2010).

5.2 Board Gender Diversity and Climate-Related Performance

The evidence presented above suggests that women directors are committed to transparency in risk disclosures. This increased presence of women directors makes financial reporting more forthcoming to outside stakeholders, alleviating concerns that the reduction in discussions about climate risks are due to the board's reluctance to flag such matters. If the reduction in climate risk disclosure is not attributable to women directors strategically withholding information, could it be that women directors genuinely assist firms in addressing and mitigating their climate-related risks?

First, we quantify the climate discussions into topics using the Latest Dirichlet Analysis (LDA), which allow us to explore the specific dimension, from which, firms' climate issues are no longer discussed following increased female board representations Blei et al. (2003). LDA is a well-liked probabilistic topic modeling method for uncovering underlying thematic structures in a set of documents. It makes the assumption that every document is a collection of topics, and that each topic is a word distribution. Automated topic extraction from massive text corpora is made possible by LDA, which assigns probability to words that correspond to various subjects by examining word co-occurrences. As a result, it is frequently utilized in applications including recommendation systems, text summarization, and document clustering (Ryans, 2021; Bochkay et al., 2023). LDA analysis broadly classify climate text into topics, which we name them as "Financial and Operations" and "Regulation" based on the most frequent ngrams in those topics. We examine this and results are reported in Table 8 where we find that the voluntarily reduction in climate issues is indeed a fall in the finance and operations related climate discussions and no significant impact on the regulation related climate discussions. These results suggest that climate risks crucial to firms' operations and finance (voluntary changes), rather than mere compliance with regulatory requirements (involuntary changes), are better addressed by a more diversified board.

[Table 8 about here.]

Second, we consider a firm's overall environmental performance using the KLD database provided by MSCI ESG Research. The KLD database features the largest corporate social research staff in the world and is widely used in academic research focusing on corporate social responsibility. KLD addresses seven qualitative areas: community, corporate governance, diversity, employee relations, environment, human rights, and product. Each section has sub-categories that can be rated positively as a strength or negatively as a concern. We focus on two variables: "Environment Strength" and "Environment Concerns." Following the prior literature (Bear et al., 2010; Jia and Zhang, 2013), we construct a composite index, the '*Environment Net Score*', by taking the strength rating and subtracting the

weakness rating. All these variables reflect ongoing environmental policies, practices, and culture from the perspectives of employees and managers. We estimate the following model (Equation (4)) where the dependent variables are the environmental strength score, weakness score, and the net score, respectively. Results are reported in Table 9.

$$\begin{aligned} \textit{Climate Performance}_{i,t+1} =& d_0 + d_1 \times \textit{Board Gender Diversity}_{i,t} + \sum_j d_j \times \mathrm{X}^j_{i,t} + \\ & \theta_t + \theta_{ind} + \theta_s + u_{i,t} \end{aligned} \tag{4}$$

[Table 9 about here.]

The results strongly support the notion that female directors contribute to better environmental management. Column (1) shows that gender diverse board has a significant positive association with environmental strengths (coefficient = 0.263, $p < 0.10$). Column (2) examines environmental concerns and shows a negative but insignificant impact (-0.190) on *Board Gender Diversity*. Most tellingly, column (3) shows that board gender diversity has a significant positive association with the net environmental score (coefficient = 0.453, $p < 0.05$). This composite measure, which captures the overall environmental performance by netting out concerns from strengths, provides compelling evidence that female directors contribute to superior environmental management.

The KLD rating also helps us to assess if a firm selectively engages in climate disclosures to window-dress its less impressive overall ESG performance, which is known as "greenwashing" practice (Walker and Wan, 2012). We follow the approach of Long et al. (2024) where the greenwashing (GW) measure for a firm i in year t is calculated as below:

$$GW_{it} = \left[\frac{ESG\_Disc_{i,t} - \overline{ESG\_Disc}}{SD(ESG\_Disc)}\right] - \left[\frac{ESG\_Rating_{i,t} - \overline{ESG\_Rating}}{SD(ESG\_Rating)}\right] \tag{5}$$

where "*ESG_Disc*" is our key independent variable, which is the percentage of climate discussions in Risk Factor section, and ESG ratings are from the KLD database. The mean and standard deviation values for each are calculated with

respect to the industry. Our results are reported in Table 10, which corroborates the point that board gender diversity improves environmental risk management, instead of indulging in greenwashing.

Lastly, we examine the impact of board gender diversity on Green House Gas (GHG) emission by re-estimating Equation (4) above, while using GHG emissions instead of KLD performance scores. The data for GHG emissions are provided by provided by Trucost, which is a widely used source of firm carbon emission used in the prior literature (Azar et al., 2021; Aswani et al., 2024). We take the log of the yearly emission values for our analysis. Table 11 provides direct evidence on the relationship between board gender diversity and firms' environmental impact by examining greenhouse gas (GHG) emissions (Azar et al., 2021). The results provide strong evidence that female board representation is associated with significantly reduced GHG emissions. In our most conservative specification with full fixed effects (column (2)), the coefficient on *Board Gender Diversity* is -1.707 (significant at the 1% level). This finding is particularly important for several reasons. First, unlike survey-based or composite environmental metrics, GHG emissions represent an objective, independently verified measure of firms' environmental impact. Second, the magnitude of the effect suggests that female directors influence not just environmental policies but also operational decisions that have material environmental consequences.

[Table 11 about here.]

These results strongly reinforce our earlier findings and the "better environmental management" hypothesis. When combined with our previous evidence on environmental performance and disclosure characteristics, a consistent pattern emerges: firms with more gender diverse boards not only discuss climate risks more efficiently in their disclosures but also demonstrate superior environmental performance. This suggests that female directors contribute to substantive improvements in environmental performance rather than merely influencing how firms communicate about environmental issues. Moreover, the substantial magnitude of the emissions reduction effect suggests that the impact of female directors on environmental performance extends beyond symbolic or policy-level changes to

fundamental operational decisions affecting firms' environmental footprint (Cohen et al., 2023).

5.3 Board Gender Diversity and Value Implications

Finally, we examine the impact of climate-related diclosures in the Risk Factor section and the board gender diversity on firm value, as proxied by its Tobin's Q, based on the standrad two-stage regression specification. In the first stage, we regress the percentage of women in board on climate risk disclosure with fixed effects for state, industry and year but without other firm controls. In the second stage, we regress the fitted values from the first stage on the Tobin's Q and controls. The following sets of Equations (6) and (7) are used to model this dependency:

$$\begin{aligned} \textit{Climate Risk Disclosure}_{i,t} =& d_0 + d_1 \textit{Board Gender Diversity}_{i,t} + \\ & \theta_t + \theta_{ind} + \theta_s + u_{i,t} \end{aligned} \tag{6}$$

$$\begin{aligned} \textit{Tobin's } Q_{i,t+1} =& d_0 + d_1 \textit{Fitted Values Stage 1}_{i,t} + \\ & \sum_j d_j \times \mathrm{X}^j_{i,t} + \theta_t + \theta_{ind} + \theta_s + u_{i,t} \end{aligned} \tag{7}$$

Table 12 reports the ultimate impact of climate risk disclosure on firm value using a two-stage least squares (2SLS) approach. This analysis is particularly important as it helps us understand the economic consequences of the environmental management practices we documented earlier. By using board gender diversity as an instrument for climate risk disclosure in the first stage, we can better isolate the causal effect of climate-related disclosures on firm value while addressing potential endogeneity concerns. Our results reveal a strong negative relationship between instrumented climate risk disclosure and firm value as measured by Tobin's Q.

[Table 12 about here.]

This finding is particularly noteworthy when interpreted alongside our earlier results. We previously documented that female directors are associated with reduced climate risk disclosure, improved environmental performance (via KLD metrics), and lower GHG emissions. Such negative relation implies that the mar-

ket views extensive climate risk disclosure as a signal of underlying environmental challenges rather than transparency per se, consistent with recent studies such as Christensen et al. (2021).

To shed more lights on the value implications, we extend the analysis to longer term impact on Tobin's Q. We repeat the same approach as Table 12, while in the 2nd stage, we test leading values of Tobin's Q in the next two, three, and four years, respectively. Results are reported in Table 13, in which, we find strong evidence that the value implications are long-lasting and persist in subsequent years.

[Table 13 about here.]

In sum, our value implication results complete a coherence narrative: female directors contribute to better environmental management (as evidenced by KLD metrics and GHG emissions), which reduces the need for extensive climate risk disclosure. The negative relationship between instrumented climate risk disclosure and firm value suggests that the market rewards this more efficient approach to environmental risk management. Our results are also in line with prior findings in Campbell et al. (2014) which show that the disclosure of factors contributing to the firm's risk is considered value relevant for investors.

6 Concluding remarks

Our study provides novel evidence on the important role that gender diversity in corporate boardrooms can play in shaping firms' environmental practices and climate change vulnerabilities. Utilizing textual analysis of the Risk-Factor Section of US firms' 10-K filings from 2005–2021, we document a significant negative association between the proportion of female directors and the quantity of climate risk disclosure in regulatory filings. We provide external validation of our results exploiting the passage of California's board gender diversity mandate using a difference-in-differences framework.

Our analysis reveals several important mechanisms through which female directors influence environmental risk management and disclosure. First, we find

that more gender-diverse boards provide more comprehensively positive and easier to read climate risk narratives, ruling out concerns about strategic information withholding. Second, our cross-sectional analyses reveal that the effect of female directors is particularly pronounced in firms with ESG committees, higher climate exposure, and older boards. Third, we document that firms with greater female board representation demonstrate superior environmental performance. Further, we show that more efficient climate risk disclosure, as instrumented by board gender diversity, is associated with higher firm values. This suggests that the market rewards the more streamlined and effective approach to environmental risk management that female directors appear to promote.

These findings have significant policy implications as regulators globally contemplate climate disclosure standards and board diversity initiatives. Our results suggest that board gender diversity mandates may have positive spillover effects on firms' environmental practices beyond their primary diversity objectives. The evidence that female directors contribute to both improved environmental performance and more efficient risk communication may be particularly relevant for policymakers seeking to enhance corporate climate risk disclosure without imposing undue reporting burdens.

References

Adams, R. B. and D. Ferreira (2009). Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics 94*(2), 291–309.

An, H., C. R. Chen, Q. Wu, and T. Zhang (2021). Corporate innovation: Do diverse boards help? *Journal of Financial and Quantitative Analysis 56*(1), 155–182.

Andreevskaia, A. and S. Bergler (2008). When specialists and generalists work together: Overcoming domain dependence in sentiment tagging. In *Proceedings of ACL-08: HLT*, pp. 290–298.

Aswani, J., A. Raghunandan, and S. Rajgopal (2024). Are carbon emissions associated with stock returns? *Review of Finance 28*(1), 75–106.

Azar, J., M. Duro, I. Kadach, and G. Ormazabal (2021). The big three and corporate carbon emissions around the world. *Journal of Financial Economics 142*(2), 674–696.

Balsam, S., J. Puthenpurackal, and A. Upadhyay (2021). Corporate opacity and effectiveness of independent female directors. *Journal of Corporate Finance 69*, 102007.

Barber, B. M. and T. Odean (2001). Boys will be boys: Gender, overconfidence, and common stock investment. *The Quarterly Journal of Economics 116*(1), 261–292.

Bear, S., N. Rahman, and C. Post (2010). The impact of board diversity and gender composition on corporate social responsibility and firm reputation. *Journal of Business Ethics 97*, 207–221.

Bebbington, J. and C. Larrinaga (2014). Accounting and sustainable development: An exploration. *Accounting, Organizations and Society 39*(6), 395–413.

Blei, D., A. Ng, and M. Jordan (2003). Latent dirichlet allocation. *Journal of Machine Learning Research 3*, 993–1022.

Bloomfield, R. (2008). Discussion of "annual report readability, current earnings, and earnings persistence". *Journal of Accounting and Economics 45*(2-3), 248–252.

Bochkay, K., S. V. Brown, A. J. Leone, and J. W. Tucker (2023). Textual analysis in accounting: What's next? *Contemporary accounting research 40*(2), 765–805.

Boulland, R., T. Bourveau, and M. Breuer (2019). Corporate websites: A new measure of voluntary disclosure.

Bourveau, T., A. Garel, and A. Romec (2024). Mandatory carbon disclosure: Evidence from france. Working Paper, available at SSRN.

Brown, S. V., X. Tian, and J. Wu Tucker (2018). The spillover effect of sec comment letters on qualitative corporate disclosure: Evidence from the risk factor disclosure. *Contemporary Accounting Research 35*(2), 622–656.

Campbell, J. L., H. Chen, D. S. Dhaliwal, H.-m. Lu, and L. B. Steele (2014). The information content of mandatory risk factor disclosures in corporate filings. *Review of Accounting Studies 19*, 396–455.

Carney, M. (2015). Breaking the tragedy of the horizon–climate change and financial stability. Speech given at Lloyd's of London.

Christensen, H., J. Hales, B. O'Dwyer, and M. E. Peecher (2024). Accounting for sustainability and climate change: Special section overview. *Accounting, Organizations and Society 113*.

Christensen, H. B., L. Hail, and C. Leuz (2021). Mandatory csr and sustainability reporting: Economic analysis and literature review. *Review of Accounting Studies 26*(3), 1176–1248.

Clarkson, P. M., Y. Li, G. D. Richardson, and F. P. Vasvari (2008). Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis. *Accounting, Organizations and Society 33*(4-5), 303–327.

Cohen, S., I. Kadach, and G. Ormazabal (2023). Institutional investors, climate disclosure, and carbon emissions. *Journal of Accounting and Economics 76*(2-3), 101640.

Croson, R. and U. Gneezy (2009). Gender differences in preferences. *Journal of Economic literature 47*(2), 448–474.

Eccles, R. G., I. Ioannou, and G. Serafeim (2014). The impact of corporate sustainability on organizational processes and performance. *Management science 60*(11), 2835–2857.

Edmans, A., C. Flammer, and S. Glossner (2023). Diversity, equity, and inclusion. National Bureau of Economic Research Working Paper Series.

Ferrell, A., H. Liang, and L. Renneboog (2016). Socially responsible firms. *Journal of Financial Economics 122*(3), 585–606.

Flammer, C., M. W. Toffel, and K. Viswanathan (2021). Shareholder activism and firms' voluntary disclosure of climate change risks. *Strategic Management Journal 42*(10), 1850–1879.

Greene, D., V. J. Intintoli, and K. M. Kahle (2020). Do board gender quotas affect firm value? Evidence from california senate bill no. 826. *Journal of Corporate Finance 60*, 101526.

Griffin, D., K. Li, and T. Xu (2021). Board gender diversity and corporate innovation: International evidence. *Journal of Financial and Quantitative Analysis 56*(1), 123–154.

Gull, A. A., M. Nekhili, H. Nagati, and T. Chtioui (2018). Beyond gender diversity: How specific attributes of female directors affect earnings management. *The British Accounting Review 50*(3), 255–274.

Gunning, R. (1952). *Technique of clear writing*. McGraw-Hill.

Hope, O.-K., D. Hu, and H. Lu (2016). The benefits of specific risk-factor disclosures. *Review of Accounting Studies 21*(4), 1005–1045.

Huang, A., J. Shen, and A. Zang (2022a). The unintended benefit of the risk factor mandate of 2005. *Review of Accounting Studies 27*, 1319–1355.

Huang, A. H., J. Shen, and A. Y. Zang (2022b). The unintended benefit of the risk factor mandate of 2005. *Review of Accounting Studies*, 1–37.

Huang, J. and D. J. Kisgen (2013). Gender and corporate finance: Are male executives overconfident relative to female executives? *Journal of Financial Economics 108*(3), 822–839.

Huynh, T. D. and Y. Xia (2021). Climate change news risk and corporate bond returns. *Journal of Financial and Quantitative Analysis 56*(6), 1985–2009.

Ilhan, E., P. Krueger, Z. Sautner, and L. T. Starks (2023). Climate risk disclosure and institutional investors. *The Review of Financial Studies 36*(7), 2617–2650.

Jia, M. and Z. Zhang (2013). Critical mass of women on bods, multiple identities, and corporate philanthropic disaster response: Evidence from privately owned chinese firms. *Journal of Business Ethics 118*, 303–317.

Jiang, Y., Y. Kang, H. Liang, and Y. G. Yang (2023). The externalities of mandatory esg disclosure. *European Corporate Governance Institute–Finance Working Paper* (880).

Kim, J.-B., C. Wang, and F. Wu (2023). The real effects of risk disclosures: evidence from climate change reporting in 10-ks. *Review of Accounting Studies 28*(4), 2271–2318.

Krueger, P., Z. Sautner, D. Y. Tang, and R. Zhong (2021). The effects of mandatory esg disclosure around the world. *Journal of Accounting Research*.

Li, F. (2008). Annual report readability, current earnings, and earnings persistence. *Journal of Accounting and Economics 45*(2-3), 221–247.

Long, L., C. Wang, and M. Zhang (2024). Does social media pressure induce corporate hypocrisy? evidence of esg greenwashing from china. *Journal of Business Ethics*, 1–28.

Loughran, T. and B. McDonald (2011). When is a liability not a liability? Textual analysis, dictionaries, and 10-Ks. *The Journal of Finance 66*(1), 35–65.

Loughran, T. and B. McDonald (2014a). Measuring readability in financial disclosures. *The Journal of Finance 69*(4), 1643–1671.

Loughran, T. and B. McDonald (2014b). Regulation and financial disclosure: The impact of plain English. *Journal of Regulatory Economics 45*(1), 94–113.

Loughran, T. and B. McDonald (2015). The use of word lists in textual analysis. *Journal of Behavioral Finance 16*(1), 1–11.

Matsumura, E. M., R. Prakash, and S. C. Vera-Muñoz (2024). Climate-risk materiality and firm risk. *Review of Accounting Studies 29*(1), 33–74.

Moss, A., J. P. Naughton, and C. Wang (2024). The irrelevance of environmental, social, and governance disclosure to retail investors. *Management Science 70*(4), 2626–2644.

Nadeem, M. (2021). Corporate governance and supplemental environmental projects: A restorative justice approach. *Journal of Business Ethics 173*(2), 261–280.

Nadeem, M. (2022). Board gender diversity and managerial obfuscation: Evidence from the readability of narrative disclosure in 10-k reports. *Journal of Business Ethics 179*(1), 153–177.

Owen, A. L. and J. Temesvary (2018). The performance effects of gender diversity on bank boards. *Journal of Banking & Finance 90*, 50–63.

Ramadorai, T. and F. Zeni (2024). Climate regulation and emissions abatement: Theory and evidence from firms' disclosures. *Management Science*.

Rogers, J. L., C. Schrand, and S. L. C. Zechman (2014). Do managers tacitly collude to withhold industry-wide bad news? Working Paper.

Ryans, J. P. (2021). Textual classification of sec comment letters. *Review of Accounting Studies 26*(1), 37–80.

Sautner, Z., L. Van Lent, G. Vilkov, and R. Zhang (2023). Firm-level climate change exposure. *The Journal of Finance 78*(3), 1449–1498.

Securities and Exchange Commission (2010). Commission guidance regarding disclosure related to climate change. Final Rule.

Shorter, G. (2013). Sec climate change disclosure guidance: An overview and congressional concerns. Congressional Research Service.

Upadhyay, A. and H. Zeng (2014). Gender and ethnic diversity on boards and corporate information environment. *Journal of Business Research 67*(11), 2456–2463.

Wahid, A. S. (2019). The effects and the mechanisms of board gender diversity: Evidence from financial manipulation. *Journal of Business Ethics 159*(3), 705–725.

Walker, K. and F. Wan (2012). The harm of symbolic actions and green-washing: Corporate actions and communications on environmental performance and their financial implications. *Journal of Business Ethics 109*, 227–242.

Tables

Table 1: Sample Selection Procedure

	Dropped	Sample *Log(Assets)*
Compustat data 2005–2021		65,776
Drop items for which Governance variables are not available	10,334	55,442
Drop items for which 10-K was not available	8,799	46,643
Drop items for which Board data was not available	30,196	16,447

Table 2: Summary Statistics

Panel A: All Sample						
	# Obs	Mean	Median	Min	Max	SD
Board Gender Diversity	16,447	15.94	15.38	0.00	37.50	10.73
Indp Board %	16,447	79.36	81.81	53.84	91.66	10.52
Log(Board Size)	16,447	2.22	2.20	1.79	2.71	0.23
Log(Assets)	16,447	8.23	8.13	5.26	11.69	1.65
Leverage	16,447	0.19	0.15	0.00	0.61	0.17
R&D	16,447	0.02	0.00	0.00	0.17	0.04
Capex	16,447	0.04	0.02	0.00	0.17	0.04
PPENT	16,447	0.80	0.88	0.20	1.00	0.22
Climate Risk Disclosure (CRD)	16,447	1.73	1.14	0.04	16.33	1.77
Panel B: Year						
Year	# Obs	*CRD* % (Mean)	CRD % (Median)	CRD % (SD)		
2005	771	2.12	1.69	1.37		
2006	717	2.56	1.92	2.15		
2007	660	1.99	1.26	1.89		
2008	753	2.48	1.75	2.52		
2009	841	2.3	1.53	2.31		
2010	1032	1.98	1.24	1.91		
2011	1064	1.9	1.28	1.86		
2012	1064	1.86	1.21	1.78		
2013	1084	1.83	1.26	1.74		
2014	1066	1.76	1.19	1.64		
2015	1069	1.71	1.25	1.52		
2016	1075	1.67	1.22	1.54		
2017	1082	1.58	1.08	1.58		
2018	1081	0.98	0.56	1.08		
2019	1093	0.95	0.51	1.07		
2020	1094	1.29	0.74	1.61		
2021	901	1.77	1.05	1.9		
Total	16,447					
Panel C: Industry						
Industry	# Obs	CRD % (Mean)	CRD % (Median)	CRD % (SD)		
Business Equipments	2751	0.97	0.74	0.88		
Chemicals	456	1.44	1.15	1.09		
Consumer Durables	349	1.49	0.81	1.35		
Consumer Non Durables	780	1.4	1.21	0.95		
Energy	543	3.97	3.38	2.67		
Finance	4235	0.77	0.54	0.64		
Healthcare	1314	0.56	0.37	0.58		
Manufacturing	1641	1.91	1.32	1.67		
Others	1800	1.68	1.18	1.63		
Shops	1706	1.45	0.92	1.32		
Telecom	199	0.31	0.31	0.01		
Utilities	673	2.85	2.41	1.88		
Total	16,447					

Note: This table reports summary statistics of the key variables used in the regressions estimated by the full sample consisting of firm-year observations (panel A), year (panel B), and industry (panel C). Variable definitions are specified in Appendix C.

Table 3: Board Gender Diversity on Climate Risk Disclosure (Baseline Test)

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***		
	(1)	(2)	(3)
Board Gender Diversity	−1.095***	−0.480***	−0.475***
	(0.170)	(0.175)	(0.170)
Indp Board %	0.726***	0.234	0.218
	(0.152)	(0.154)	(0.156)
Log(Board Size)	−0.062	−0.0003	−0.017
	(0.108)	(0.099)	(0.101)
Log(Assets)	0.099***	0.066***	0.071***
	(0.019)	(0.015)	(0.015)
Leverage	−0.121	0.005	0.027
	(0.113)	(0.099)	(0.099)
R&D	−0.850***	−0.955***	−0.826***
	(0.279)	(0.298)	(0.310)
Capex	−1.275	−1.274	−1.674**
	(1.155)	(0.885)	(0.821)
PPENT	−2.251***	−1.116***	−1.124***
	(0.202)	(0.206)	(0.196)
Business Complexity	0.108***	0.019	0.015
	(0.038)	(0.036)	(0.036)
Year FE	No	Yes	Yes
Industry FE	No	Yes	Yes
State FE	No	No	Yes
Observations	16,447	16,447	16,447
Adjusted R^2	0.196	0.292	0.315

Note: This table reports the impact of the board gender diversity on climate risk disclosure in the risk factor section (section 1A) of 10-K reports. The sample period is 2005–2021. Our dependent variable is defined to be the percentage of climate-related sentences in the risk factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes controls but no fixed effects, column (2) includes controls and fixed effects for industry and year, and column (3) features controls and fixed effects for industry, year and state. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table 4: Impact of California Bill on Climate Risk Disclosure

Panel A: Pre- and Post- matching

Dependent Variable: ***Treated Firms***		
	Pre Match	Post Match
	(1)	(2)
Board Gender Diversity	-1.074^{***}	-0.033
	(0.041)	(0.113)
Indp Board %	-0.155^{***}	-0.160
	(0.044)	(0.112)
Log(Board Size)	-0.359^{***}	0.040
	(0.023)	(0.062)
Log(Assets)	-0.017^{***}	0.004
	(0.003)	(0.009)
Leverage	0.174^{***}	-0.061
	(0.026)	(0.070)
R&D	0.048	0.431
	(0.110)	(0.267)
Capex	-0.735^{***}	-0.134
	(0.187)	(0.461)
PPENT	0.025	-0.099
	(0.031)	(0.081)
Business Complexity	0.006	0.006
	(0.009)	(0.024)
Observations	12,705	2,186
Adjusted R^2	0.126	0.001

Panel B: Post-matching Differences

Variable	Treated (N = 1093)	Control (N = 1093)	Differences	T Stat
Indp Board %	0.80	0.80	0.00	-1.26
Log(Board Size)	9.27	9.22	-0.05	0.62
Log(Assets)	8.15	8.13	-0.01	0.18
Leverage	0.19	0.20	0.01	-0.68
R&D	0.02	0.02	-0.00	1.13
Capex	0.04	0.04	0.00	0.66
PPENT	0.79	0.80	0.01	-0.93

Panel C: Difference-in-Differences Estimation Results

Dependent Variable: ***Climate Risk Disclosure (t+1)***		
	(1)	(2)
*Post*Treated*	-0.397^{***}	-0.386^{***}
	(0.124)	(0.123)
Post	-0.154	-0.174
	(0.128)	(0.121)
Treated	0.239^{***}	0.225^{***}
	(0.079)	(0.080)
Control	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
State FE	No	Yes
Observations	2,186	2,186
Adjusted R^2	0.267	0.303

Note: This table reports the results of California Senate Bill 2018 no. 826's impact on climate risk disclosure. Panel A shows pre- and post-matching regressions for treated firms. Panel B presents results. Panel C displays the difference-in-differences analysis for climate risk disclosure in 10-K reports' risk factor sections. Robust standard errors clustered at the firm level are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 5: Cross-Sectional Tests

	Dependent Variable: ***Climate Risk Disclosure (t+1)***					
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Board Gender Diversity × *ESG Comm*	−1.255**	−1.268**				
	(0.604)	(0.646)				
Board Gender Diversity × *Climate Exp Dummy*			−0.834***	−0.887***		
			(0.224)	(0.220)		
Board Gender Diversity × *Dir Age Dummy*					−0.708***	−0.672***
					(0.250)	(0.249)
Board Gender Diversity	0.364	0.282	−0.048	−0.021	−0.139	−0.146
	(0.558)	(0.608)	(0.163)	(0.160)	(0.187)	(0.178)
ESG Comm	0.082	0.001				
	(0.117)	(0.121)				
Climate Exp Dummy			0.198***	0.197***		
			(0.047)	(0.047)		
Dir Age Dummy					0.175***	0.162***
					(0.055)	(0.054)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes	No	Yes
Observations	5,857	5,857	15,095	15,095	13,811	13,811
Adjusted R^2	0.309	0.361	0.310	0.331	0.305	0.331

Note: This table reports the effect of the board gender diversity on the climate risk disclosure in the risk factor section (section 1A) of 10-K reports. The sample period is 2005-2021. Our dependent variable is the percentage of climate sentences in the risk factor section of 10-K reports. Definitions of the other variables are in Appendix C. Columns (1,3,5) includes only controls without the industry and year fixed effects. Columns (2,4,6) controls for industry, year and state fixed effects. Robust standard errors clustered at the firm level are reported in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table 6: Board Gender Diversity and the Readability of Climate Risk Disclosure

Variables	Dependent Variable: ***Fog Index (t+1)***	
	(1)	(2)
Board Gender Diversity	−12.159***	−11.797***
	(3.745)	(3.583)
Indp Board %	1.179	0.767
	(3.400)	(3.466)
Log(Board Size)	−1.560	−1.503
	(1.965)	(1.983)
Log(Assets)	1.782***	1.900***
	(0.333)	(0.324)
Leverage	2.109	2.297
	(2.529)	(2.522)
R&D	−17.575*	−13.996
	(9.127)	(9.144)
Capex	−42.297***	−49.030***
	(15.550)	(14.839)
PPENT	−26.962***	−27.792***
	(4.062)	(3.996)
Business Complexity	0.954	0.954
	(0.785)	(0.773)
Year FE	Yes	Yes
Industry FE	Yes	Yes
State FE	No	Yes
Observations	16,447	16,447
Adjusted R^2	0.282	0.300

Note: This table reports the impact of the board gender diversity on the readability (fog index) of climate risk disclosure in the risk factor section of 10-K reports. The sample period is 2005-2021. Our dependent variable is the fog index of climate risk disclosure in the risk factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes controls with year and industry fixed effects and column (2) includes controls with year, industry, and state fixed effects. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Table 7: Board Gender Diversity and the Tone of Climate Risk Disclosure

Variables	Dependent Variable: ***Tone (t+1)***	
	(1)	(2)
Board Gender Diversity	0.069**	0.059*
	(0.035)	(0.034)
Indp Board %	0.019	0.019
	(0.033)	(0.033)
Log(Board Size)	0.022	0.017
	(0.018)	(0.018)
Log(Assets)	−0.012***	−0.013***
	(0.003)	(0.003)
Leverage	−0.003	−0.003
	(0.023)	(0.022)
R&D	0.137*	0.129
	(0.081)	(0.083)
Capex	0.004	0.038
	(0.148)	(0.136)
PPENT	0.097***	0.109***
	(0.035)	(0.032)
Business Complexity	−0.007	−0.007
	(0.007)	(0.007)
Year FE	Yes	Yes
Industry FE	Yes	Yes
State FE	No	Yes
Observations	16,447	16,447
Adjusted R^2	0.133	0.153

Note: This table reports the impact of the board gender diversity on the tone of climate risk disclosure in the risk factor section (section 1A) of 10-K reports. The sample period is 2005-2021. Our dependent variable is the Tone of climate sentences in the risk factor section of 10-K reports Loughran and McDonald (2011). Definitions of the other variables are in Appendix C. Column (1) includes controls with year and industry fixed effects and Column (2) includes controls with year, industry, and state fixed effects. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Table 8: Board Gender Diversity and Climate Risk Disclosure Topics

Variable	Dependent Variable: ***Climate Risk Disclosure Topics (t+1)***	
	Finance and Operations	Regulation
Board Gender Diversity	−0.349**	−0.067
	(0.145)	(0.098)
Indp Board %	0.282**	−0.092
	(0.142)	(0.073)
Log(Board Size)	−0.049	0.017
	(0.082)	(0.057)
Log(Assets)	0.051***	0.016**
	(0.014)	(0.007)
Leverage	0.046	0.005
	(0.087)	(0.044)
R&D	−0.469**	−0.197
	(0.221)	(0.198)
Capex	−1.001	−0.548*
	(0.815)	(0.285)
PPENT	−0.982***	−0.113
	(0.192)	(0.074)
Business Complexity	−0.018	0.024
	(0.032)	(0.017)
Year FE	Yes	Yes
Industry FE	Yes	Yes
State FE	Yes	Yes
Observations	16,447	16,447
Adjusted R^2	0.308	0.064

Note: This table reports the impact of the board gender diversity on climate risk disclosure topics. The sample period is 2005–2021. Our dependent variable is defined to be the percentage of climate-related sentences in the risk factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes controls but no fixed effects, column (2) includes controls and fixed effects for industry and year, and column (3) features controls and fixed effects for industry, year and state. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table 9: Board Gender Diversity and the Environmental Scores

Variable	Dependent Variable: ***Environment Strength (t+1)***	Dependent Variable: ***Environment Concern (t+1)***	Dependent Variable: ***Environment Net Score (t+1)***
	(1)	(2)	(3)
Board Gender Diversity	0.263*	−0.190	0.453**
	(0.146)	(0.136)	(0.178)
Indp Board %	0.277**	0.266**	0.011
	(0.114)	(0.121)	(0.149)
Log(Board Size)	0.123*	0.031	0.092
	(0.069)	(0.070)	(0.077)
Log(Assets)	0.222***	0.135***	0.087***
	(0.017)	(0.018)	(0.018)
Leverage	−0.152*	−0.081	−0.071
	(0.088)	(0.094)	(0.101)
R&D	1.844***	0.125	1.719***
	(0.432)	(0.301)	(0.446)
Capex	1.077**	−0.917*	1.995***
	(0.537)	(0.527)	(0.650)
PPENT	−0.226**	−0.367***	0.141
	(0.107)	(0.130)	(0.130)
Business Complexity	0.013	0.007	0.006
	(0.026)	(0.024)	(0.030)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Observations	5,467	5,467	5,467
Adjusted R^2	0.337	0.346	0.181

Note: This table reports the impact of the board gender diversity on the KLD environment scores. The sample period is 2005-2021. Our dependent variables are the environment strengths (column (1)), concerns (column (2)), and the net environment score (column (3)) (strengths − concerns). Definitions of the other variables are in Appendix C. All columns include controls with year, industry and state fixed effects. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Table 10: Board Gender Diversity and Greenwashing

Variable	Dependent Variable: ***Greenwashing (t+1)***		
Board Gender Diversity	-1.492^{***}	-1.264^{***}	-1.347^{***}
	(0.277)	(0.320)	(0.291)
Indp Board %	-0.150	-0.085	-0.096
	(0.240)	(0.258)	(0.257)
Log(Board Size)	-0.111	-0.109	-0.111
	(0.165)	(0.167)	(0.161)
Log(Assets)	-0.122^{***}	-0.152^{***}	-0.155^{***}
	(0.026)	(0.029)	(0.028)
Leverage	-0.124	0.007	0.078
	(0.176)	(0.171)	(0.165)
R&D	-3.882^{***}	-4.818^{***}	-4.277^{***}
	(0.668)	(0.792)	(0.814)
Capex	-4.056^{***}	-4.005^{***}	-4.375^{***}
	(1.007)	(1.016)	(0.957)
PPENT	-0.807^{***}	-1.224^{***}	-1.210^{***}
	(0.219)	(0.276)	(0.271)
Business Complexity	-0.038	0.001	0.0002
	(0.059)	(0.062)	(0.061)
Year FE	No	Yes	Yes
Industry FE	No	Yes	Yes
State FE	No	No	Yes
Observations	5,467	5,467	5,467
Adjusted R^2	0.057	0.076	0.107

Note: This table reports the impact of the percentage of women in boards on greenwashing. The sample period is 2005–2021. Our dependent variable is defined to be the greenwashing measure by a firm calculated as the difference between the standardized percentage of climate sentences and the KLD ratings. Definitions of the other variables are in Appendix C. Column (1) includes controls but no fixed effects, column (2) includes controls and fixed effects for industry and year, and column (3) features controls and fixed effects for industry, year and state. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table 11: Board Gender Diversity and Firms' Greenhouse Gas Emissions

Variable	Dependent Variable: ***GHG Emissions (t+1)***	
	(1)	(2)
Board Gender Diversity	-1.816^{***}	-1.707^{***}
	(0.336)	(0.341)
Indp Board %	0.476	0.307
	(0.348)	(0.306)
Log(Board Size)	-0.108	-0.139
	(0.192)	(0.189)
Log(Assets)	-0.070^{**}	-0.072^{**}
	(0.034)	(0.031)
Leverage	0.437^{*}	0.518^{**}
	(0.231)	(0.231)
R&D	-0.378	0.214
	(1.149)	(1.147)
Capex	-6.618^{***}	-5.885^{***}
	(1.388)	(1.350)
PPENT	-4.660^{***}	-4.388^{***}
	(0.373)	(0.365)
Business Complexity	0.116	0.093
	(0.074)	(0.073)
Year FE	Yes	Yes
Industry FE	Yes	Yes
State FE	No	Yes
Observations	10,539	10,539
Adjusted R^2	0.742	0.759

Note: This table reports the impact of the board gender diversity on the green house gas emissions. The sample period is 2005-2021. Our dependent variable is the log of green house gas emissions by the firm in a year. Definitions of the other variables are in Appendix C. Column (1) includes controls with year and industry fixed effects and column (2) includes controls with year, industry and state fixed effects. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Table 12: Board Gender Diversity and Value Implications

Variable	Dependent Variable: ***Tobin's Q (t+1) (2nd Stage)***	Dependent Variable: ***Tobin's Q (t+1) (2nd Stage)***
	(1)	(2)
Fitted Climate Risk Disclosure %	−5.113***	
	(1.304)	
Fitted Climate Risk Disclosure %		−5.551***
		(1.540)
Indp Board %	−0.282	−0.288
	(0.229)	(0.232)
Log(Board Size)	0.024	0.063
	(0.135)	(0.134)
Log(Assets)	−0.112***	−0.112***
	(0.023)	(0.024)
Leverage	0.515***	0.481***
	(0.151)	(0.148)
R&D	7.367***	7.084***
	(0.921)	(0.967)
Capex	8.036***	7.588***
	(0.853)	(0.848)
PPENT	1.037***	0.886***
	(0.173)	(0.174)
Business Complexity	−0.197***	−0.202***
	(0.059)	(0.057)
Year FE	Yes	Yes
Industry FE	Yes	Yes
State FE	No	Yes
Observations	16,447	16,447
Adjusted R^2	0.309	0.326

Note: This table reports the impact of the board gender diversity on the firm value using a two-staged regression approach based on the regression specification in Equations (6) and (7). The sample period is 2005-2021. Our dependent variable is climate risk disclosure in the first stage and tobin's q in the second stage. Definitions of the other variables are in Appendix C. Columns (1) and (2) include controls with year, industry and year, industry and state fixed effects respectively. Standard errors are robust and clustered at the firm level, with values reported in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Table 13: Board Gender Diversity and Long Term Valuation

Variable	Dependent Variable: ***Tobin's Q (t+2) (2nd Stage)***	Dependent Variable: ***Tobin's Q (t+3) (2nd Stage)***	Dependent Variable: ***Tobin's Q (t+4) (2nd Stage)***
	(1)	(2)	
Fitted Climate Risk Disclosure %	−5.836***	−3.730***	−2.301**
	(1.924)	(1.327)	(0.983)
Indp Board %	−0.291	−0.291	−0.270
	(0.260)	(0.278)	(0.293)
Log(Board Size)	0.083	0.072	0.032
	(0.151)	(0.160)	(0.168)
Log(Assets)	−0.119***	−0.112***	−0.104***
	(0.026)	(0.027)	(0.028)
Leverage	0.531***	0.607***	0.642***
	(0.162)	(0.171)	(0.182)
R&D	7.413***	7.663***	8.047***
	(1.070)	(1.126)	(1.205)
Capex	7.742***	8.091***	8.562***
	(0.966)	(1.048)	(1.143)
PPENT	0.874***	0.860***	0.865***
	(0.191)	(0.199)	(0.174)
Business Complexity	−0.205***	−0.198***	−0.191***
	(0.063)	(0.065)	(0.069)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Observations	13,414	12,078	10,859
Adjusted R^2	0.333	0.341	0.348

Note: This table reports the impact of the board gender diversity on the firm value using a two-staged regression approach based on the regression specification in Equations (6) and (7). The sample period is 2005-2021. Our dependent variable is climate risk disclosure in the first stage and tobin's q in the second stage. Definitions of the other variables are in Appendix C. Columns (1) and (2) include controls with year, industry and year, industry and state fixed effects respectively. Standard errors are robust and clustered at the firm level, with values reported in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Appendices

A Climate Words and Phrases

Below is the list of the words and phrases used to identify climate-related sentences in the Risk Factor section.

climate change; global warming; greenhouse effects; carbon emissions; carbon tax; climate overshoot; megadroughts; climate realists; ipcc; greta thunberg; climate warming; greenhouse gas; greenhouse warming; carbon footprint; climate crisis; climate strike; megafire; paris agreement; pollution; rio summit; climate activists; global temperature; greenhouse gases; carbon dioxide; carbon sequestration; climate emergency; climate velocity; megafires; sea-level rise; earth day; kyoto protocol; climate activist; global temperatures; greenhouse effect; co2; carbon stock; climate justice; megadrought; anthropogenic global; heatwaves; climate culture

B Climate Risk Disclosure in Risk Factor section

To illustrate the idea of such climate text embedded within the Risk Factor section of the 10-K, we consider an example. The following text is an extract taken from the '**American Airline Group Inc**' in their Risk Factor Section.

2013:

> "*There is increasing global regulatory focus on climate change and greenhouse gas emissions. For example, the EU has established the Emissions Trading Scheme (ETS) to regulate carbon dioxide emissions in the EU. similarly, within the US, there is an increasing trend toward regulating greenhouse gas emissions directly under the Clean Air act. Several states are also considering initiatives to regulate emissions of greenhouse gases, primarily through the planned development of greenhouse gas emissions inventories and/or regional greenhouse gas cap*

and trade programs. However, such climate change-related regulatory activity in the future may adversely affect our business and financial results by requiring us to reduce our emissions, purchase allowances or otherwise pay for our emissions."

2014:

"*In response to a 2012 ruling by the US court of appeals District of Columbia circuit requiring the EPA to make a final determination on whether aircraft GHG emissions cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, the EPA announced in September 2014 that it is in the process of making a determination regarding aircraft GHG emissions and anticipates proposing an endangerment finding by May 2015. There is increasing global regulatory focus on climate change and greenhouse gas (GHG) emissions. However, such climate change-related regulatory activity in the future may adversely affect our business and financial results by requiring us to reduce our emissions, purchase allowances or otherwise pay for our emissions.*"

The firm had no climate-related discussion (according to our definition) in the year 2015.

2016:

"*The EPA recently issued an endangerment finding that aircraft engine GHG emissions cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare, which is a precursor to EPA regulation of aircraft engine GHG emission standards. We are subject to risks associated with climate change, including increased regulation to reduce emissions of greenhouse gases. There is increasing global regulatory focus on climate change and GHG emissions. In addition, in December 2015, at the 21st conference of the parties to the United Nations Framework Convention on Climate Change (UNFCCC's COP21), over 190 countries, including the United States, reached an agreement to reduce global greenhouse gas emissions. While*

there is no express reference to aviation in this international agreement, to the extent the United States and other countries implement this agreement or impose other climate change regulations, either with respect to the aviation industry or with respect to related industries such as the aviation fuel industry, it could have an adverse direct or indirect effect on our business. In February 2016, the ICAO committee on aviation environmental protection recommended that ICAO adopt carbon dioxide certification standards that would apply to new type aircraft certified beginning in 2020, and would be phased in for newly manufactured existing aircraft type designs starting in 2023. However, such climate change-related regulatory activity in the future may adversely affect our business and financial results by requiring us to reduce our emissions, purchase allowances or otherwise pay for our emissions."

It is noteworthy that for this example, the main concern is the risk which emanates from the fundamental uncertainty in anticipating the impact of government regulation, in this case, related to laws mandating reduction in emissions.

C Variable Definition

Variable	Definition
Tone	Calculated as per Loughran and McDonald (2011).
Board Gender Diversity	Number of Women in Board divided by the number of board members. Source: ISS.
Women Board Dummy	Takes value 1 if the number of womens directors is greater than 0. Source: ISS.
Climate Risk Disclosure (CD) Dummy	Takes value 1 if the number of sentences containing climate-related words is non-zero in the risk factor section and 0 otherwise. Source: EDGAR
Climate Risk Disclosure	Percentage of Sentences which contain at least one climate related word/phrase in the Risk Factor Section (1A) of 10-K report. Source: EDGAR
Greenwashing	Difference between the standardized percentage of sentences which contain at least one climate related word/phrase in the Risk Factor Section (1A) of 10-K report and the KLD ESG ratings. Source: EDGAR and KLD
Indep Board %	Ratio of independent directors to total number of board members. Source: ISS.
Log(Board Size)	Number of directors on board. Source: ISS.
Log(Assets)	Natural logarithm of assets. Source: COMPUSTAT.
Leverage	Total long-term and short-term debt divided by total assets. Source: COMPUSTAT.
R&D	*R&D* expense divided by total assets. Source: COMPUSTAT.
Capex	*Capex* divided by total assets. Source: COMPUSTAT.
PPENT	1-(Net Property, Plant and Equipment/total assets). Source: COMPUSTAT.
Business Complexity	Number of operating segments. Source: COMPUSTAT.
Treat	Takes Value 1 for firms which have more than 0 requirement number of womens in the board as per California senate bill no. 826. Source: ISS.
Post	Takes Value 1 for the years after 2018 as per California Senate bill no. 826.
Tobin's Q	Natural logarithm of the ratio of (market value of equity + book value of debt) to book value of assets. Source: COMPUSTAT.
Green House Gas (GHG) Emissions	Natural logarithm of the yearly GHG emissions by the firms. Source: Trucost

D Robustness Checks

Table D1: Alternative Variables Definitions and Model Specifications

Variable	Dependent Variable: ***Climate Discussion % (t+1)***	Dependent Variable: ***Climate Discussion Dummy (t+1)***	Dependent Variable: ***Climate Discussion Dummy (t+1)***
Board Gender Diversity Dummy	-0.118^{**}		
	(0.051)		
Board Gender Diversity		-0.178^{**}	-1.291^{***}
		(0.083)	(0.255)
Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Observations	16,447	16,447	16,447
Model	OLS	OLS	Logit
Adjusted R^2	0.314	0.229	
McFadden R^2			0.228

Note: This table reports the impact of firms' board gender diversity on the level of climate risk disclosure in the Risk Factor (RF) section (section 1A) of 10-K reports. The sample period is 2005-2021. Our dependent variable is the percentage of sentences containing at least one climate-related word/phrase (climate risk disclosure %) and Climate Risk Disclosure dummy (columns (2) and (3)) in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Columns (1) and (2) use panel estimation model with fixed effects and include benchmark control variables. Column (3) uses the Logit model with controls for industry, year and state fixed effects. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table D2: Alternative Clustering

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***	
Board Gender Diversity	−0.480***	−0.475***
	(0.178)	(0.160)
Indp Board %	0.234	0.218
	(0.221)	(0.246)
Log(Board Size)	−0.0003	−0.017
	(0.088)	(0.086)
Log(Assets)	0.066***	0.071***
	(0.019)	(0.020)
Leverage	0.005	0.027
	(0.114)	(0.117)
R&D	−0.955***	−0.826***
	(0.290)	(0.311)
Capex	−1.274	−1.674*
	(0.966)	(0.932)
PPENT	−1.116***	−1.124***
	(0.310)	(0.307)
Business Complexity	0.019	0.015
	(0.032)	(0.032)
Year FE	Yes	Yes
Industry FE	Yes	Yes
State FE	No	Yes
Standard error clustering	State	State
Observations	16,447	16,447
Adjusted R^2	0.292	0.315

Note: This table reports the effect of the ratio of womens in the board on the percentage of Climate Risk Disclosure in the Risk Factor (RF) section (section 1A) of 10-K reports. The sample period is 2005-2021. Our dependent variable is the percentage of Climate Risk Disclosure in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes controls with the industry, year, and state fixed effects with standard error clustered at firm level. Column (2) controls for industry, year, and state fixed effects. Robust standard errors clustered at the state level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table D3: Controlling for Institutional Ownership

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***			
Board Gender Diversity	−0.504***	−0.500***	−0.490***	−0.422**
	(0.179)	(0.179)	(0.179)	(0.167)
IO HHI	−0.613			
	(0.407)			
IO Mean %		−0.0004		
		(0.001)		
IO Mean			−0.000	
			(0.000)	
IO Block Mean				−0.000*
				(0.000)
Indp Board %	0.134	0.146	0.146	0.145
	(0.159)	(0.158)	(0.158)	(0.156)
Log(Board Size)	0.010	0.009	0.009	−0.032
	(0.105)	(0.105)	(0.105)	(0.104)
Log(Assets)	0.066***	0.069***	0.075***	0.078***
	(0.016)	(0.016)	(0.017)	(0.017)
Leverage	0.080	0.077	0.075	0.068
	(0.101)	(0.101)	(0.101)	(0.100)
R&D	−0.835***	−0.851***	−0.806***	−0.829***
	(0.305)	(0.305)	(0.304)	(0.309)
Capex	−1.361*	−1.308	−1.272	−1.622**
	(0.821)	(0.821)	(0.825)	(0.814)
PPENT	−1.020***	−1.011***	−1.008***	−1.033***
	(0.196)	(0.196)	(0.196)	(0.199)
Business Complexity	0.012	0.012	0.012	0.006
	(0.036)	(0.036)	(0.036)	(0.036)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	15,256	15,251	15,256	14,486
Adjusted R^2	0.319	0.319	0.319	0.311

Note: This table reports the impact of the percentage of women in boards on climate risk disclosure in the Risk Factor (RF) section (section 1A) of 10-K reports. It includes additional control variables which capture institutional ownership (IO) of firms. The sample period is 2005–2021. Our dependent variable is defined to be the percentage of climate-related sentences in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes the Herfindahl Index of IO, column (2) includes the mean percentage of IO, column (3) includes the mean of IO, column (4) includes the block mean of IO. All columns have the industry, year, and state fixed effects. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Table D4: Sample Duration Restricted to be 2010–2021

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***		
Board Gender Diversity	-1.227^{***}	-0.474^{***}	-0.470^{***}
	(0.183)	(0.183)	(0.180)
Indp Board %	0.611^{***}	0.269	0.248
	(0.176)	(0.174)	(0.178)
Log(Board Size)	-0.131	-0.061	-0.088
	(0.118)	(0.108)	(0.112)
Log(Assets)	0.095^{***}	0.067^{***}	0.075^{***}
	(0.020)	(0.016)	(0.017)
Leverage	-0.163	-0.014	0.009
	(0.118)	(0.103)	(0.103)
R&D	-1.041^{***}	-0.991^{***}	-0.864^{***}
	(0.299)	(0.318)	(0.328)
Capex	-0.508	-1.473	-1.866^{*}
	(1.332)	(1.050)	(0.960)
PPENT	-2.140^{***}	-1.171^{***}	-1.173^{***}
	(0.203)	(0.226)	(0.214)
Business Complexity	0.113^{***}	0.019	0.016
	(0.039)	(0.037)	(0.037)
Year FE	No	Yes	Yes
Industry FE	No	Yes	Yes
State FE	No	No	Yes
Observations	12,705	12,705	12,705
Adjusted R^2	0.202	0.293	0.322

Note: This table reports the impact of the percentage of women in boards on climate risk disclosure in the Risk Factor (RF) section (section 1A) of 10-K reports. The sample period is 2010–2021 in light of the of SEC 2010 rule for firms to declare climate risks. Our dependent variable is defined to be the percentage of climate-related sentences in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes controls but no fixed effects, column (2) includes controls and fixed effects for industry and year, and column (3) features controls and fixed effects for industry, year and state. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively.

Table D5: Climate Risk Disclosure in MD&A (Section 7) and Business Description (Section 1)

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***		
Board Gender Diversity	-1.802^{***}	-0.736^{***}	-0.736^{***}
	(0.249)	(0.249)	(0.242)
Indp Board %	1.282^{***}	0.431^{**}	0.413^{*}
	(0.229)	(0.220)	(0.220)
Log(Board Size)	-0.062	0.003	-0.008
	(0.151)	(0.133)	(0.134)
Log(Assets)	0.165^{***}	0.119^{***}	0.126^{***}
	(0.026)	(0.022)	(0.022)
Leverage	-0.198	0.002	0.043
	(0.163)	(0.139)	(0.140)
R&D	-0.833^{*}	-1.127^{**}	-0.957^{**}
	(0.426)	(0.460)	(0.480)
Capex	-2.099	-1.985	-2.359^{**}
	(1.638)	(1.240)	(1.166)
PPENT	-3.789^{***}	-1.865^{***}	-1.830^{***}
	(0.299)	(0.286)	(0.274)
Business Complexity	0.188^{***}	0.027	0.024
	(0.055)	(0.050)	(0.050)
Year FE	No	Yes	Yes
Industry FE	No	Yes	Yes
State FE	No	No	Yes
Observations	16,447	16,447	16,447
Adjusted R^2	0.252	0.371	0.388

Note: This table reports the impact of the percentage of women in boards on climate risk disclosure in MD&A (Section 7) and Business Description (Section 1) of 10-K reports. The sample period is 2005–2021. Our dependent variable is defined to be the percentage of climate-related sentences in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes controls but no fixed effects, column (2) includes controls and fixed effects for industry and year, and column (3) features controls and fixed effects for industry, year and state. Robust standard errors clustered at the firm level are in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively