Board Gender Diversity and Climate Risk Disclosure*†

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Abstract

We examine whether women's representation on corporate boards is related to the discussion of climate-related risks in firms' Risk Factor section in their 10-Ks. We show that inclusion of more women is associated with significant reductions in climate-related discussions in firms' disclosures. This result is driven by the amelioration of climate-related risks in firms with more gender-diverse boards. Further, we show that for such firms, environmental ratings and valuations are higher, and their disclosures' climate-related text is more readable and less negative in tone. We further validate our results by using the passage of the California Senate Bill No. 826 as an exogenous shock using a difference-in-differences framework. The results are especially stronger for firms with a board ESG committee and those more exposed to climate risks. In general, our study offers evidence that improving gender diversity in the boardroom can mitigate firms' climate risks and improve their valuation as well as environmental performance.

Keywords: Female Board; Climate Disclosure; Risk Factor; Textual Analysis

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1 Introduction

Corporations face increasing pressure to address climate change risks and enhance environmental sustainability practices. Climate risk refers to the potential negative impacts of climate change on natural and human systems, including economic, social, and environmental dimensions. Empirical data shows that CO2 concentrations have increased from pre-industrial levels of about 280 parts per million (ppm) to over 410 ppm in recent years.[1] Industrial activities, including cement production, chemical manufacturing, and metal smelting, transportation, energy production and consumption emit significant quantities of GHGs and other pollutants.[2]

Climate risk disclosure has emerged as a critical component of corporate reporting, reflecting the growing recognition of climate change's potential impact on businesses and economies.[3] Investors are increasingly demanding more detailed and reliable information on climate risks to make informed investment decisions. Studies have shown that companies with higher investor scrutiny tend to provide more comprehensive climate risk disclosures (Eccles and Serafeim, 2013). By being transparent about climate-related risks, companies can maintain or enhance their legitimacy in the eyes of stakeholders (Eccles et al., 2011; Krueger et al., 2021; Ramadorai and Zeni, 2024). This is particularly evident in industries with high environmental impacts, where stakeholders expect greater transparency (Clarkson et al., 2008; Boulland et al., 2019; Bourveau et al., 2024). It is also found that mandating ESG disclosure can lead to both positive and negative externalities in the ESG domain (Jiang et al., 2023).[4]

The board of directors plays a critical role in corporate governance, overseeing management and ensuring that the interests of shareholders and other stakeholders are protected. An essential aspect of this responsibility is ensuring high-quality

[1] https://www.noaa.gov/news-release/carbon-dioxide-now-more-than-50-higher-than-pre-industrial-levels

[2] https://www.epa.gov

[3] 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).

[4] 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.

disclosure practices (Ettredge et al., 2011; Chan et al., 2014). Prior literature documents a positive association between the disclosure quality of a firm and certain characteristics of its board such as the level of board independence and composition of its monitoring committees (Klein, 2002; Anderson et al., 2004). Diverse boards are believed to enhance decision-making quality, including corporate disclosure (Adams and Ferreira, 2009).[5] In this paper, we attempt to understand whether more gender diverse boards also improve the disclosures related to climate change. This investigation is important as corporate boards have been going through significant changes by adding more female directors and its unclear whether the rise in board gender diversity corresponds to the way corporations disclose climate risks.

Prior research has examined the determinants and consequences of environmental and climate change disclosure (Matsumura et al., 2014; Griffin et al., 2017; Christensen et al., 2021; Matsumura et al., 2024). However, the role of corporate boards, which generally provide leadership and oversight on major strategic and investment decisions in improving climate change related risk disclosures is relatively underexplored. The intersection of board gender diversity and climate risk disclosure has garnered considerable attention in recent years. As environmental, social, and governance (ESG) factors become more critical in corporate decision-making, understanding the influence of board composition on climate-related disclosures is vital for stakeholders, including investors, regulators, and the public. In light of the recent rise in board gender diversity, we are particularly interested in understanding how it impacts a firm's disclosure policies related to climate risk.

There are some studies (Liao et al., 2015; Ben-Amar et al., 2017) that find a positive association between gender diverse boards and environmental disclosures. Nadeem (2022) present evidence on how increased board gender diversity is associated with significantly lower obfuscation in corporate disclosures and how that improves the readability of financial reports. Further, female directors have been characterized as stricter monitors of management actions (Nadeem, 2021) and are

[5]Research indicates that board diversity positively impacts disclosure quality. For instance, Gull et al. (2018) found that gender-diverse boards are associated with more transparent disclosure practices.

likely to protect stakeholder interests (Adams and Ferreira, 2009; Cumming et al., 2015). On the other hand, Some studies report mixed or insignificant findings regarding the impact of board gender diversity on climate risk disclosure. For example, a study by Prado-Lorenzo and Garcia-Sanchez (2010) found no significant relationship between board gender diversity and environmental disclosure in Spanish companies. These could be due the risk averse nature of female directors (Barber and Odean, 2001; Adams and Ferreira, 2009; Croson and Gneezy, 2009; Huang and Kisgen, 2013) or better implementation of stringent environment practices and policies, thus preventing climate issues in the first place (Croson and Gneezy, 2009). While prior studies examine the impact of board gender diversity on corporate social responsibility (Turban and Greening, 1997), to the best of our knowledge this is the first study that examines the impact of board gender diversity on climate-related discussions in the Risk Factor section of firms' 10-K.

We investigate whether board gender diversity influences the disclosure of climate change risks in regulatory filings. We focus on the inclusion of climate change-related discussion in the Risk Factor section of annual 10-K filings from 2005 to 2021. Our textual analysis identifies climate change-related discussions by searching for relevant keywords and phrases in the Risk Factor section of the firms' 10-K. The purpose of this section is limited to illustrating the sum total of risks that a company faces Any mitigating factors related to a particular risk, however, are not discussed in this section. Numerous prominent studies examine the importance and impact of the Risk Factors section and show that it provides relevant information to investors and other stakeholder alike (Campbell et al., 2014; Hope et al., 2016; Brown et al., 2018).[6] This section provides a comprehensive overview of the risks that the company faces, ranging from general market risks to specific risks related to the industry, competition, regulations, economic conditions, and even internal factors like management and operations. Firms need to communicate these risks transparently to maintain investor trust and comply with regulatory requirements.

We extract the climate-related discussion from the Risk Factor section of the 10-K using a corpus of climate-related words and phrases and identify sentences

[6]In 2005, the SEC mandated that firms disclose risk factors to provide useful information about firm risk.

containing such terms as the 'climate text' corresponding to the firm's disclosure. Analyzing the relationship between board gender diversity and climate risk-related discussions, we find that an increase in women's representation in the board significantly reduces the amount of climate risk disclosure in 10-K filings. This negative association is further intensified following the passage of California's board gender diversity mandate in 2018. The 2018 California Senate Bill No. 826 required that publicly traded corporations headquartered in California include at least one female director on their board by December 31, 2019. Furthermore, it required at least two female directors if a board had five directors and three female directors if the board had six or more directors by December 31, 2021. This mandate provides a unique exogenous shock which can help to examine the impact of women's representation on boards on firms' climate-related discussion in their disclosure.

We also document that climate-related discussion for firms with more gender-diverse boards is more readable and less negatively-toned, consistent with enhanced monitoring of environmental exposures, and in line with Nadeem (2022) who present evidence on how increased board gender diversity is associated with significantly less obfuscation in company disclosure and improved readability of corporate filings. Finally, we provide evidence that climate risk disclosure and board gender diversity positively impact firm value by lowering environmental risk perceptions. We also examine the impact of Senate Bill No. 826 (2018) which mandated a specific percentage of female directors on the climate discussion in the risk factor section (Greene et al., 2020). The results are robust to alternative model specifications and variable definitions.

Our findings have important policy implications as regulators globally contemplate corporate climate risk disclosure standards and board diversity mandates (Ben-Amar et al., 2017; Peters and Romi, 2014). From a theoretical perspective, this study contributes to the literature exploring the real effects of gender diversity in corporate leadership and boardroom dynamics. Overall, our results suggest that improving board gender diversity can facilitate transparency regarding firms' environmental practices and climate change vulnerabilities.

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 in the board on

climate discussion in the 10-K as well as robustness. Finally, section 5 concludes.

2 Literature Review and Hypotheses

We discuss competing predictions of negative or positive association of board gender diversity on climate risk disclosures in the section 2.1.

2.1 Board gender diversity and climate disclosure

2.1.1 Positive Association

The presence of female board members often correlates with greater transparency and accountability (Gull et al., 2018), leading to increased climate disclosures. Studies suggest that companies with female 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; Cumming et al., 2015). Gender diverse boards are also associated with more effective and efficient internal organizations (Adams and Ferreira, 2009; Post and Byron, 2015). Additionally, female 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). Finally, board gender diversity has been found to be associated with higher ethical standards leading to fewer securities fraud (Cumming et al., 2015), earnings management (Gull et al., 2018) as well as environment violations (Liu, 2018). This proactive approach results in more detailed reporting on how climate change could impact the company's operations and financial performance. The integration of climate risks into financial reports ensures that all stakeholders are well-informed about the potential impacts of climate change, thereby promoting a culture of openness and responsibility.

Based on the above discussion, one can expect that more women in boards could positively impact transparency, stakeholder orientation and information sharing.

2.1.2 Negative Association

Conversely, the volume of climate-related disclosures could get reduced in the presence of more female directors. First, female directors' cautious and risk-averse nature (Barber and Odean, 2001; Adams and Ferreira, 2009; Croson and Gneezy, 2009; Huang and Kisgen, 2013) and intense disutility from negative outcomes (Croson and Gneezy, 2009) can lead to better management of climate-related risks, which in turn, could reduce the need to discuss such risk sources in disclosure documents. Hence, female directors are more likely to implement stringent environmental practices and policies, which can prevent climate issues from arising in the first place. This preemptive approach to risk management can significantly lower the frequency and severity of climate-related incidents, making extensive disclosures less necessary. Second, female board members' strong emphasis on ESG often results in a greater focus on environmental sustainability (Bear et al., 2010; Post et al., 2011; McGuinness et al., 2017). Female boards' ethical orientation implies that female directors are likely to prioritize the mitigation of climate issues from the outset, thereby reducing the need for extensive climate discussions and disclosures. Third, the presence of female directors can influence the entire board to adopt more rigorous standards for environmental accountability, thus embedding these values into the company's core practices and policies (McGuinness et al., 2017).

Hence, by fostering a culture of ethical responsibility, female directors may encourage the firm to address environmental issues more proactively (compared to their male counterparts) thereby reducing the overall impact of these issues on the company's operations as well as disclosures.

2.1.3 Hypothesis 1

Clearly there is a relation between female representation in firms' board and the volume of climate-related discussion in firms' disclosure documents. On one hand, due to the correlation between women in board and attributes of firm transparency, accountability and shareholder orientation, one could expect a positive relation between women's representation in board and climate-related discussion in the risk factor section of the firms' 10-K. On the other hand however, based on studies

which indicate that women are more risk-averse than their male counterparts one could expect more preemptive action on climate-related matters, consequently resulting in reduced climate-related discussion in firms' risk factor section of the 10-K.

Given plausible arguments for both positive and negative associations between board gender diversity and climate disclosure, we present our first hypothesis in the null form, as follows:

H1: There is no association between the proportion of women in the board and the volume of climate risk disclosures in the risk factor section of 10-K

We may fail to reject the null hypothesis if climate risk disclosures are considered boilerplate in nature (Kravet and Muslu, 2013; Hope et al., 2016) and if so the amount of climate-related discussions might not vary significantly from firm to firm.

3 Data, Sample Selection, and Key Variable Construction

We begin by downloading the 10-K files for all US firms during 2005-2021 from the SEC website.[7] We note that the SEC mandated the inclusion of the Risk Factor section in the year 2005 from which our sample starts (Huang et al., 2022). 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 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' level of climate-related disclosure, we textually analyze the 'Risk Factor' section (Section 1A) for every downloaded 10-K file (Campbell et al., 2014; Hope et al., 2016). We first break down the risk factor section into a

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

collection of sentences by identifying all punctuation marks. Then we identify climate-related sentences from others by identifying climate-related words/phrases ('ngrams'),[8] which capture the presence of climate-related discussion in each sentence.[9] 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).[10] The list of terms and phrases for quantifying climate-related discussion is taken from two major sources in line with Pathak and Hammoudeh (2023): the United States Environmental Protection Agency (`https://www.epa.gov`) and Wordstream (`https://www.wordstream.com`). Each sentence that contains at least one such climate-related ngram is defined as a climate-related sentence. For each firm-year combination, we identify such climate-related sentences and collect them together to form the "climate text" of the Risk Factor section.[11] We define the firm variable "*Climate Risk Disclosure*" [CRD] as the percentage of sentences that contain some climate text (at least one climate related word/phrase) in the Risk Factor section in its 10-K.

Our key independent variable, '*Female Board %*', is the percentage of female directors. Following the 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 expenditures (*Capex/Assets*), net property, plant, and equipment divided by total assets (*PPENT/Assets*), and a dummy for *Business Complexity* (number of segments).

Table 2 presents summary statistics for the key variables used in this study (Panel A) as well as by year (Panel B) and by the industry (Panel C). The number of firm-year observations is evenly spread across each year between 750 and 1,100. Across industry however, we find that most firms with climate risk disclosure discussion are in the "Utilities" industry (76% firms), followed by "Energy" (60%)

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

[9] The full list of such words used in our study is taken from Pathak and Hammoudeh (2023) and is presented in Appendix A.

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

[11] Appendix B presents some examples which illustrate instances of climate discussion in the Risk Factor section of the 10-K.

and "Manufacturing" (32%).

[Table 2 about here.]

4 Empirical Results

4.1 Baseline Results

To gauge the association between womens' board representation and firms' *climate risk disclosures*, we run unbalanced panel estimations with year, industry and state fixed effects, and with clustered, robust standard errors where clustering is done at the firm level (see equation 1). The dependent variable '*Climate Risk Disclosure*' is number of sentences in the Risk Factor Section (1A) that contain at least one climate related word/phrases scaled by the total number of sentences in the section. Our key independent variable, '*Female Board %*', is the percentage of female directors on the board.

Following the 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 expenditures (*Capex/Assets*), net property, plant, and equipment divided by total assets (*PPENT/Assets*), and a dummy for *Business Complexity* (*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.

$$\begin{aligned} \textit{Climate Risk Disclosure}_{i,t+1} = & d_0 + d_1 \times \textit{Female Board \%}_{i,t} + \sum_j d_j \times \text{ Controls}^j_{i,t} + \\ & \theta_t + \theta_{Ind} + \theta_S + u_{i,t} \end{aligned} \tag{1}$$

Table 3 presents our baseline results. In column (1), with no fixed effects, we find a negative and statistically significant relationship between the percentage

of female directors and the firms' *climate risk disclosure*. Thus, considering an average board size of 9, an addition of 1 woman director (1 standard deviation) would correspond to a $6.64 * 1.77 = 11.75$ percent fall in climate-related sentences in the Risk Factor section of 10-K.

In column (2), as we add year fixed effects and industry fixed effects, the magnitude of the coefficient for *Female Board %* reduces but remains negative and statistically significant at the 1% level. Thus, considering an average board size of 9, an addition of 1 woman director (1 standard deviation) would correspond to a $2.90 * 1.77 = 5.13$ percent fall in climate-related sentences in the Risk Factor section of 10-K. As we add state fixed effects in column (3), the baseline result continues to hold. Looking at the control variables, the coefficient estimates are largely consistent with the literature. For example, larger firms (*Log(Assets)*) is positively and significantly associated with climate disclosure, implying larger firms engage in more *Climate Risk Disclosure*. Additionally, firms with higher *R&D* and *PPENT* engage in less climate related disclosure. The economic significance is the same as column 2.

[Table 3 about here.]

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 female directors to capture the board gender diversity, we define a binary variable, *Female Board Dummy*, which takes the value of 1 if there is at least one female board member, and zero otherwise. We report those results in column (1) of Appendix D. Second, instead of examining the percentage of climate risk discussion, we define the *climate risk disclosure* as a binary variable, *Climate Discussion Dummy*, which takes the value of 1 if there is climate risk discussions in the Risk Factor section, and zero otherwise. We use OLS and Logit models in columns (2) and (3) of Appendix D, respectively. The results remain robust. Third, we cluster our standard errors at state-level as opposed to firm-level (shown in Table D2). Fourth, we add different measures of the institutional ownership of the firm as an additional control (Table D3) and restrict

the sample from 2010 onwards in light of the 2010 SEC interpretive guidance that specifies that companies are expected to disclose climate risk that can materially affect registrants' business operations and financial performance (Securities and Exchange Commission, 2010) (results presented in table D4). Finally, we quantity the climate disclosure in the Management Discussion and Analysis (MD&A) section as well as the Business Description section in line with (Securities and Exchange Commission, 2010; Matsumura et al., 2024) who specify the importance of climate disclosure in section 1 (Business Description) and section 7 (MD&A) of 10-K. Results are presented in table D5. We continue to find significantly negative coefficient estimates on the variable of interest.

[Tables D1, D2, D3, D4 and D5 about here.]

4.3 Addressing Endogeneity Concerns: Exogeneous Shock to Board Gender Diversity Due to Passage of California Senate Bill

While we find a negative association between the presence of female directors and a firm's *climate risk disclosures* that is robust to alternative variable definitions and models, 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. That could also lead to the same relationship that we find in our regression analyses and yet, does not support the idea that more gender diverse boards necessarily lead to more environmentally friendly disclosures. Therefore, to enhance our causal inference, we exploit a quasi-natural experiment, the passage of 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.[12] We treat the passage of this law as an exogenous change in the landscape of female board presence, compelling all firms headquartered in California to comply by mandating an increase in the number of female directors among those firms

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

with two or fewer women on their boards.[13] The law essentially requires that firms with 4, 5, and 6 or more board members needed to have a minimum 1, 2, and 3 female directors in their board, 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 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 9 Panel A, we report the estimation results of the pre-match regression and the post-match diagnostic regression. Different from column (1), in column (2) of Table 9 Panel B, 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.

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. In Table 9 Panel C, we estimate the following model based on the matched sample, which consists of all observations of the 1,093 unique matched pairs across 2010-2018. In particular, we attempt the standard difference-in-differences specification in Equation (2) below, with the dummy variable *Post* taking value 1 after 2018 and zero otherwise, and the dummy variable *Treatment* assuming value 1 for the set of firms with required

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

to add more female directors to their board per the California law.

$$\begin{aligned} \textit{Climate Risk Disclosure}_{i,t+1} = & d_0 + d_1 \times \text{Treated}_i + d_2 \times \text{Post}_t + \\ & d_3 \text{Treated}_i \times \text{Post}_t + \\ & \sum_j d_j \times \text{Firm Controls}_{i,t}^j + \\ & \theta_t + \theta_{Ind} + \theta_S + u_{i,t} \end{aligned} \tag{2}$$

Importantly, we observe negative and significant coefficient estimates on *Treated*×*Post*, reinforcing our baseline findings that firms tend to disclose less about climate risks in their 10-K reports following the increase in female directors. Collectively, our robustness checks suggest that our main set of results continue to hold well.

[Table 9 about here.]

4.4 Cross Sectional Analysis

Could the climate disclosure vary across firms based on cross-sectional variation? 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 with more pressure from external stakeholders. Further, similar cross-sectional variation is observed in the impact of females in the board with respect to firm risk (Kim et al., 2023) and performance (Owen and Temesvary, 2018). On similar lines, Laksmana et al. (2012) provide evidence on how executives' pay can impact firms' disclosures. Sautner et al. (2023) develop a method that identifies the attention paid by earnings call participants to firms' climate change exposures using climate related keywords. They show that the measures are useful in predicting important real outcomes related to the net-zero transition, in particular, job creation in disruptive green technologies and green patenting, and that they contain information that is priced in options and equity markets. Keeping in mind such variations in impact due to firms' cross-sectional characteristics, we examine if the negative impact of women's board representation on climate disclosure varies with respect to cross-sectional firm characteristics.

We examine four major cross-sectional characteristics: i) presence of an ESG committee, ii) climate exposure of the firm, iii) executive pay component, and iv) directors' age. Table 4 presents the results for the impact of the percentage of women's board representation on the amount of climate-related discussion in the Risk Factor section in the presence of an ESG committee (columns 1 and 2), climate exposed firms (columns 3 and 4), CEO bonus (columns 5 and 6) and directors' age (columns 7 and 8). 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), "CEO Bonus Dummy" which takes value 1 when the CEO bonus is higher than the median 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. We find that the impact of the percentage of females in the board on the percentage of climate discussions is exacerbated in the presence of an ESG committee, if the firm is more exposed to climate actions and in the case of older directors. On ther other hand, the impact is attenuated if the directors' bonuses are high.

[Table 4 about here.]

4.5 Additional Analysis

4.5.1 Do Female Directors Strategically Withhold Information?

So far, the evidence presented suggests that the increase in female directors reduces *climate risk disclosures*. One explanation could be that female directors tend to withhold information, and the reduction in *climate risk disclosure* is a manifestation of this tendency. To this end, we run two additional tests by textually analyzing the readability and the tone of climate discussions in the Risk Factor section of 10-K. Further, it has also been established, with respect to a range of readability measures, that smaller and less lengthy disclosures are easier

to read and comprehend and are not related to withholding information (Loughran and McDonald, 2014). This is because withholding information is generally accomplished by burying text in lengthier disclosures (Bloomfield, 2008; Loughran and McDonald, 2011, 2014).

We compute the readability of climate discussion 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, calculated as $\frac{\text{total number of words}}{\text{total number of sentences}}$, and ii) percentage of complex words (words more than two syllables), calculated as $\frac{\text{total number of complex words}}{\text{total number of words}}$. The Fog Index is a linear combination of both these components.[14] 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 text.

We employ the specification below to gauge the impact of gender diversity on the readability and tonality ('*Climate Risk Disclosure Characteristics*') of a firm's financial disclosures,:

$$\begin{aligned} \textit{Climate Risk Disclosure Characteristics}_{i,t+1} = & d_0 + d_1 \textit{Female Board \%}_{i,t} + \\ & \sum_j d_j \times \text{Controls}^j_{i,t} + \\ & \theta_t + \theta_{Ind} + \theta_S + u_{i,t} \end{aligned} \tag{3}$$

Table 5 presents results for the regressions of disclosure readability. It shows that an increase in the number of female directors corresponds to a significant decrease in the Fog Index levels for the Risk Factor (RF) section of the 10-K. In other words, an increase in female directors' representation is associated with a significant improvement in the climate text readability in the Risk Factor section. This finding aligns with Nadeem (2021), who present a significant positive impact

[14] $0.4 * [\text{Average Words Per Sentence} + \text{Percentage of Complex Words}]$

of board gender diversity on the readability of the 10-K.

[Table 5 about here]

Table 6 presents results for the tone of the climate-related text which indicates that an increase in female board representation is associated with a significantly less negative tone in the Risk Factor section of the 10-K.[15]. The stronger presence of female directors significantly decreases the negativity of the tone.

[Table 6 about here]

Collectively, the evidence presented above suggests that female directors are committed to transparency in risk disclosures. This increased presence of female 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.

4.5.2 Board Gender Diversity and Climate-Related Performance

If the reduction in *climate risk disclosure* is not attributable to female directors strategically withholding information, could it be that female directors genuinely assist firms in addressing and mitigating their climate-related risks? In this subsection, we consider a firm's overall environmental performance using the KLD database provided by MSCI ESG Research as well as the Green House Gas (GHG) emissions provided by the Environmental Protection Agency.

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. From 1991 to 2000, the database covered approximately 650 firms sourced from the S&P 500 Index and the Domini 400 Social Index. In 2001, it expanded to include the 1000 Largest U.S. Companies, and in 2002, the Large Cap Social Index. Finally, in 2003, KLD included 2000 Small Cap U.S. Companies and the Broad Market Social Index. 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

[15]It is notable that the tone of the Risk Factor section is predominantly negative (Campbell et al., 2014)

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; McGuinness et al., 2017; Liu, 2018), we construct a composite index, the Environment Net Score, by taking the strength rating and subtracting the weakness rating. Those scores should 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 7

$$\textit{Environment Score}_{i,t+1} = d_0 + d_1 \times \textit{Female Board \%}_{i,t} + \sum_j d_j \times \text{Firm Controls}^j_{i,t} + \theta_t + \theta_{Ind} + \theta_S + u_{i,t} \quad (4)$$

We observe that board gender diversity significantly and positively influences both the environment strength score and the net score for the following year (Bear et al., 2010; Jia and Zhang, 2013; McGuinness et al., 2017; Liu, 2018). This might explain the reduced climate-related discussion in the Risk Factor section, as a greater number of females on the board brings better corporate practices in climate related issues which reduces the need to report climate-related risks.

[Table 7 about here.]

We further examine the impact of Green High Gas (GHG) emissions by the firms in the presence of females in the board using the below equation:

$$\textit{GHG Emissions}_{i,t+1} = d_0 + d_1 \times \textit{Female Board \%}_{i,t} + \sum_j d_j \times \text{Firm Controls}^j_{i,t} + \theta_t + \theta_{Ind} + \theta_S + u_{i,t} \quad (5)$$

The data for GHG emissions is provided by the US EPA. We take the log of the yearly emission values for our analysis. We find similar results for the impact of board gender diversity on the GHG emission of the firms as presented in Table 8. The table presents the negative and significant impact of the percentage of females

in the board on the GHG emissions of the firms year after.

[Table 8 about here.]

4.5.3 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 following two stage regression specification:

$$\begin{aligned} \textit{Climate Risk Disclosure}_{i,t} =& d_0 + d_1 \textit{Female Board \%}_{i,t} + \\ & \theta_t + \theta_{Ind} + \theta_S + u_{i,t} \qquad (6) \\ \textit{Tobin's Q}_{i,t+1} =& d_0 + d_1 \textit{Fitted Values Stage 1}_{i,t} + \\ & \sum_j d_j \times \text{Firm Controls}^j_{i,t} + \\ & \theta_t + \theta_{Ind} + \theta_S + u_{i,t} \qquad (7) \end{aligned}$$

Results are presented in Table 10 where we find that in line with Pathak and Hammoudeh (2023), the presence of climate discussion in the Risk Factor section is associated with a significant decrease in firm value. This result is 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.

[Table 10 about here.]

5 Concluding remarks

Our study provides novel evidence on the important role that gender diversity in corporate boardrooms can play around firms' environmental practices and climate change vulnerabilities. Utilizing textual analysis of 10-K filings, we document a significant negative association between the percentage of female directors and the quantity of *climate risk disclosure* in regulatory filings. This result is amplified following the passage of California's board gender diversity mandate. We

also find that more gender-diverse boards provide more comprehensively positive and easier to read climate risk narratives, consistent with enhanced monitoring over environmental exposures.

Importantly, we show that both *climate risk disclosure* and board gender diversity are value-relevant based on their negative association with firm valuations. Our findings have significant policy implications as regulators globally contemplate climate disclosure standards and board diversity initiatives.

Future work can explore how the presence of female directors from different ethnic/racial backgrounds and career experiences influences environmental transparency. As climate disclosure regulations solidify, researchers can assess whether mandated transparency levels the playing field across firms or whether the quality of disclosure is impacted by board composition.

Overall, our study contributes to the growing literature on the real effects of board- room diversity and lays the groundwork for future work exploring the drivers and implications of corporate environmental transparency through the lens of board composition.

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Tables

Table 1: Sample Creation

	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
Female Board %	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	16,447	1.73	1.14	0.04	16.33	1.77
Panel B: Year						
Year	# Obs	Climate Discussion % (Mean)	Climate Discussion % (Median)	Climate Discussion % (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	Climate Discussion % (Mean)	Climate Discussion % (Median)	Climate Discussion % (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: Impact of Females In Board on Climate Discussion in the RF section

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***		
	(1)	(2)	(3)
Female Board %	−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 effect of the ratio of females in board on the climate discussion 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 sentences in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes only controls without the industry and year fixed effects. Column (2) controls for industry and year fixed effects and Column (3) 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 4: Impact of Females In Board on Climate Discussion in the RF section (cross section)

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
*Female Board %*ESG Committee*	−1.255**	−1.268**						
	(0.604)	(0.646)						
*Female Board %*Climate Exposed Dummy*			−0.834***	−0.887***				
			(0.224)	(0.220)				
*Female Board %*CEO Bonus Dummy*					0.494**	0.551**		
					(0.238)	(0.238)		
*Female Board %*Directors' Age Dummy*							−0.708***	−0.672***
							(0.250)	(0.249)
Female Board %	0.364	0.282	−0.048	−0.021	−0.552***	−0.556***	−0.139	−0.146
	(0.558)	(0.608)	(0.163)	(0.160)	(0.188)	(0.182)	(0.187)	(0.178)
ESG Committee	0.082	0.001						
	(0.117)	(0.121)						
Climate Exposed Dummy			0.198***	0.197***				
			(0.047)	(0.047)				
CEO Bonus Dummy					−0.029	−0.045		
					(0.061)	(0.060)		
Directors' Age Dummy							0.175***	0.162***
							(0.055)	(0.054)
Indp Board %	0.084	0.101	0.244	0.238	0.248	0.229	0.196	0.160
	(0.332)	(0.286)	(0.158)	(0.159)	(0.154)	(0.156)	(0.176)	(0.178)
Log(Board Size)	−0.118	−0.158	0.062	0.038	0.002	−0.015	0.016	−0.010
	(0.210)	(0.207)	(0.091)	(0.092)	(0.099)	(0.101)	(0.109)	(0.112)
Log(Assets)	0.091***	0.101***	0.065***	0.069***	0.066***	0.071***	0.063***	0.069***
	(0.035)	(0.035)	(0.016)	(0.015)	(0.015)	(0.015)	(0.016)	(0.016)
Leverage	0.141	0.270	0.093	0.109	0.008	0.031	0.089	0.100
	(0.191)	(0.181)	(0.098)	(0.099)	(0.099)	(0.099)	(0.104)	(0.105)
R&D	−1.193**	−0.984	−1.010***	−0.807***	−0.950***	−0.826***	−1.142***	−0.898***
	(0.552)	(0.623)	(0.288)	(0.304)	(0.299)	(0.309)	(0.306)	(0.327)
Capex	−2.803	−2.257	−0.838	−1.260	−1.256	−1.651**	−0.628	−1.046
	(1.750)	(1.372)	(0.927)	(0.864)	(0.880)	(0.818)	(0.995)	(0.903)
PPENT	−1.513***	−1.382***	−1.062***	−1.066***	−1.115***	−1.121***	−0.985***	−0.994***
	(0.424)	(0.389)	(0.218)	(0.208)	(0.206)	(0.196)	(0.218)	(0.206)
Business Complexity	−0.028	−0.030	0.021	0.016	0.019	0.015	0.007	0.003
	(0.076)	(0.073)	(0.034)	(0.035)	(0.036)	(0.036)	(0.039)	(0.039)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	5,857	5,857	15,095	15,095	16,447	16,447	13,811	13,811
Adjusted R^2	0.309	0.361	0.310	0.331	0.293	0.315	0.305	0.331

Note: This table reports the effect of the ratio of females in board on the climate discussion 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 sentences in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Columns (1,3,5 and 7) includes only controls without the industry and year fixed effects. Columns (2,4,6 and 8) 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 5: Impact of Females In Board on Climate Discussion in the RF section (Fog)

Variables	Dependent Variable: ***Fog Index (t+1)***	
	(1)	(2)
Female Board %	−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 effect of the ratio of females in board on the readability (proxied by Fog Index) of climate discussion in the Risk Factor (RF) section (section 1A) of 10-K reports. The sample period is 2005-2021. Our dependent variable is the Fog Index of climate sentences 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 reported in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table 6: Impact of Females In Board on Climate Discussion in the RF section (Tone)

Variables	Dependent Variable: ***Tone (t+1)***	
	(1)	(2)
Female Board %	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 effect of the ratio of females in board on the tone of climate discussion in the Risk Factor (RF) 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. 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 reported in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table 7: Impact of Females In Board on Climate Discussion in the RF section (ESG)

Variable	Dependent Variable: ***Environment Strength (t+1)***	Dependent Variable: ***Environment Concern (t+1)***	Dependent Variable: ***Environment Net Score (t+1)***
	(1)	(2)	(3)
Female Board %	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 effect of the ratio of females in board on the 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 reported in parentheses. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table 8: Impact of Females In Board on Climate Discussion in the RF section (GHG Emissions)

Variable	Dependent Variable: ***GHG Emissions (t+1)***	
	(1)	(2)
Female Board %	-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 effect of the ratio of females in board on the log of Green House Gas (GHG) emissions. The sample period is 2005-2021. Our dependent variable is the log of GHG 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

Table 9: Impact of California Bill on Climate Discussion (Diff in Diff)

Panel A: Pre and Post Regression		
Dependent Variable: ***Treated Firms***		
	Pre Match	Post Match
	(1)	(2)
Female Board %	−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: Propensity Score Matching

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

Panel C: Difference in Difference

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)
Indp Board %	0.399*	0.322
	(0.239)	(0.240)
Log(Board Size)	−0.067	−0.131
	(0.183)	(0.189)
Log(Assets)	0.086***	0.099***
	(0.027)	(0.028)
Leverage	−0.200	−0.186
	(0.194)	(0.205)
R&D	−1.067**	−0.645
	(0.443)	(0.485)
Capex	−2.355	−2.779
	(1.903)	(1.740)
PPENT	−1.363***	−1.386***
	(0.355)	(0.309)
Business Complexity	0.024	0.020
	(0.060)	(0.061)
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 Panel A reports the mean values and respective difference in mean and t statistics for the *Climate Risk Disclosure* and controls variables after the Propensity Score Matching. Panel B reports the effect of Treatmeant variable defined with respect to the California senate bill 2018 no. 826 on *Climate Risk Disclosure* and Controls before and after matching the sample using PSM. The sample period is 2010-2021 to ensure a balanced sample. Our dependent variable is the Treatment variable which takes value 1 for treatment firm and 0 otherwise. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively. Panel C reports the effect of the California senate bill 2018 no. 826 using Difference in Difference for firms headquartered in California, with respect to the impact of ratio of females in the board on the climate discussion in the Risk Factor (RF) section (section 1A) of 10-K reports. The sample period is 2010-2021 to ensure a balanced sample. Our dependent variable is the percentage of climate sentences in the Risk Factor section of 10-K reports. The post variable takes value 1 after the year 2018 and the treated variables takes value 1 for california firms with females to add in the board post the law. Definitions of the other variables are in Appendix C. The analysis includes all controls with year and industry 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 10: Impact of Females In Board on Climate Discussion in the RF section (Firm Value)

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 Dir %	−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 effect of the ratio of females in board and percentage of climate discussion in the Risk Factor (RF) section (section 1A) of 10-K reports on the firm value using a two-staged regression approach. The sample period is 2005-2021. Our dependent variable is percentage of climate sentences 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. Robust standard errors clustered at the firm level are 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 Discussion 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
Average words per sentence	The number of words in the 10-K filing divided by the total number of sentence termination characters after removing those associated with headings and abbreviations.
Percent complex words	The percentage of 10-K words with more than two syllables.
Fog index	Calculated as $0.4\times$(*average words per sentence* + *percent complex words*). High values of the *Fog index* imply less readable text.
Tone	Calculated as per Loughran and McDonald (2011).
Treatment	Takes Value 1 for firms which have more than 0 requirement number of females 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.
Female Board %	Number of females in board divided by the Log (Board *Log(Assets)*). Source: ISS.
Female Board Dummy	Board Gender Diversity Dummy (BGD), taking value 1 if the number of females directors is greater than 0. Source: ISS.
Climate Discussion (CD) Dummy	Climate Dummy, taking 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
Female CEO	Dummy taking value 1 if the CEO is a female and 0 otherwise. Source: ISS
Indep Dir	Ratio of independent directors to Log (Board *Log(Assets)*). 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.
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: https://www.epa.gov.

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)***
Female Board Dummy	-0.118^{**}		
	(0.051)		
Female Board %		-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
Model	OLS	OLS	Logit
Observations	16,447	16,447	16,447
Adjusted R^2	0.314	0.229	
McFadden R^2			0.228

Note: This table reports the effect of the Board Gender Diversity on the climate discussion 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 sentences (column 1) and climate discussion dummy (columns 2 and 3) in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) and (2) use OLS model and include controls with the industry, year and state fixed effects. Column (3) uses Logit model with 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 D2: Alternative Variables Definitions and Model Specifications (State Clustering)

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***	
Female Board %	−0.157*	−0.178**
	(0.085)	(0.083)
Indp Board %	−0.048	−0.050
	(0.071)	(0.072)
Log(Board Size)	−0.032	−0.024
	(0.044)	(0.043)
Log(Assets)	0.036***	0.038***
	(0.007)	(0.007)
Leverage	0.053	0.053
	(0.051)	(0.051)
R&D	−0.596***	−0.603***
	(0.226)	(0.230)
Capex	−0.646**	−0.702***
	(0.270)	(0.253)
PPENT	−0.399***	−0.421***
	(0.066)	(0.062)
Business Complexity	0.011	0.012
	(0.017)	(0.016)
Year FE	Yes	Yes
Industry FE	Yes	Yes
State FE	Yes	Yes
Observations	16,447	16,447
Adjusted R^2	0.211	0.229

Note: This table reports the effect of the ratio of females in the board on the percentage of climate discussion 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 discussion 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 with standard error clustered at state level. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table D3: Alternative Variables Definitions and Model Specifications (Institutional Ownership)

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***			
Female Board %	−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 effect of the ratio of females in the board on the percentage of climate discussion in the Risk Factor (RF) section (section 1A) of 10-K reports with measures of Institutional Ownership (IO) as additional control. The sample period is 2005-2021. Our dependent variable is the percentage of climate discussion in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes the Herfindal 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 with standard error clustered at firm level. Coefficients marked with *, **, and *** are significant at 10%, 5%, and 1%, respectively

Table D4: Alternative Variables Definitions and Model Specifications (Post 2010 Sample)

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***		
Female Board %	−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 effect of the ratio of females in board on the climate discussion 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 the percentage of climate sentences in the Risk Factor section of 10-K reports. Definitions of the other variables are in Appendix C. Column (1) includes only controls without the industry and year fixed effects. Column (2) controls for industry and year fixed effects and Column (3) 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 D5: Alternative Variables Definitions and Model Specifications (Including MDA and Business Description sections)

Variable	Dependent Variable: ***Climate Risk Disclosure (t+1)***		
Female Board %	−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 effect of the ratio of females in board on the climate discussion in the Risk Factor (RF - section 1A), Management Discussion and Analysis (MDA - section 7), and Business Description (section 1) 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. Column (1) includes only controls without the industry and year fixed effects. Column (2) controls for industry and year fixed effects and Column (3) 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