The Eco Gender Gap in Boardrooms

Finance Working Paper N° 861/2022
March 2023

Po-Hsuan Hsu
National Tsing Hua University, National University of Singapore and ABFER

Kai Li
University of British Columbia, ABFER, CAFR, CSFN and ECGI

Yihui Pan
University of Utah

ECGI Working Paper Series in Finance

The Eco Gender Gap in Boardrooms

Working Paper N° 861/2022
March 2023

Po-Hsuan Hsu
Kai Li
Yihui Pan

We are grateful for helpful comments from Pat Akey, Utpal Bhattacharya, Alice Bonaime, Yingmei Cheng, Darwin Choi, Alex Corhay, Waverly Ding, Adam Exstein, Yuan Gao, David Goldreich, Bing Han, Simi Kedia, Chris Lamoureux, Hao Liang, Stefano Lovo, Glades McKenzie, Sergey Mityakov, Darius Palia, Daniel Skarlicki, Ting Xu, Jing Xu, Chelsea Yang, Liyan Yang, Irene Yi, Alminas Zaldokas, and Yuxiang Zheng, seminar participants at Central University of Finance and Economics, Columbia University, Florida State University, Rutgers University, University of Arizona, University of Macau, University of Toronto, University of Utah, and conference participants at the NTHU Symposium on Sustainable Finance and Economics and HEC-HKUST Sustainable Finance seminar. We thank excellent research support from McKenna Carpenter, Jianqiang Chen, Gen Li, Huayi Tang, and Chi-Yang Tsou. Li acknowledges financial support from the Canada Research Chair in Corporate Governance, the Social Sciences and Humanities Research Council of Canada (Grant Number: 435-2022-0285), and the Montalbano Centre for Responsible Leadership Development at UBC Sauder School of Business. All errors are our own.

Abstract

Using firm- and facility-level measures of corporate environmental performance over the period 2002–2021, we establish a positive association between board gender diversity and corporate environmental performance. For identification, we exploit cross-sectional variations in opportunities for women in states where directors went to college and temporal variations in discrimination against women when directors were college age, as well as the California law change in 2018 mandating female directors for firms headquartered in California. In terms of channels, we show that female directors bring more expertise on sustainability in boardrooms than male directors, that female directors are more likely to sit on sustainability committees and key monitoring committees than male directors, and that boards with more female directors are more likely to link top executives' compensation to corporate ESG performance. We conclude that there are important environmental benefits for boards to be gender diverse.

Keywords: female directors; boards; corporate environmental performance; pollution prevention; emissions; board gender quota

JEL Classifications: G30, G38, G41

Po-Hsuan Hsu*
Professor
National Tsing Hua University
101, Section 2, Kuang-Fu Road
Hsinchu City , Taiwan
e-mail: pohsuan.hsu@gmail.com

Kai Li
W.M. Maurice Young Professor of Finance
University of British Columbia, Sauder School of Business
2053 Main Mall
Vancouver, BC V6T 1Z2, Canada
phone: +1 604 822 8353
e-mail: kai.li@sauder.ubc.ca

Yihui Pan
Associate Professor of Finance
University of Utah
Salt Lake City, UT 84112, USA
phone: +1-801-587-9672
e-mail: Yihui.Pan@Eccles.Utah.edu

*Corresponding Author

The Eco Gender Gap in Boardrooms*

Po-Hsuan Hsu, Kai Li, and Yihui Pan

This version: March 2023

Abstract

Using firm- and facility-level measures of corporate environmental performance over the period 2002–2021, we establish a positive association between board gender diversity and corporate environmental performance. For identification, we exploit cross-sectional variations in opportunities for women in states where directors went to college and temporal variations in discrimination against women when directors were college age, as well as the California law change in 2018 mandating female directors for firms headquartered in California. In terms of channels, we show that female directors bring more expertise on sustainability in boardrooms than male directors, that female directors are more likely to sit on sustainability committees and key monitoring committees than male directors, and that boards with more female directors are more likely to link top executives' compensation to corporate ESG performance. We conclude that there are important environmental benefits for boards to be gender diverse.

Keywords: female directors; boards; corporate environmental performance; pollution prevention; emissions; board gender quota

JEL classification: G30; G38; G41

* Po-Hsuan Hsu, Department of Quantitative Finance, College of Technology Management, National Tsing Hua University, Email: pohsuanhsu@mx.nthu.edu.tw. Kai Li, Sauder School of Business, University of British Columbia, Email: kai.li@sauder.ubc.ca. Yihui Pan, Department of Finance, David Eccles School of Business, University of Utah, Email: yihui.pan@eccles.utah.edu. We are grateful for helpful comments from Pat Akey, Utpal Bhattacharya, Alice Bonaime, Yingmei Cheng, Darwin Choi, Alex Corhay, Waverly Ding, Adam Exstein, Yuan Gao, David Goldreich, Bing Han, Simi Kedia, Chris Lamoureux, Hao Liang, Stefano Lovo, Glades McKenzie, Sergey Mityakov, Darius Palia, Daniel Skarlicki, Ting Xu, Jing Xu, Chelsea Yang, Liyan Yang, Irene Yi, Alminas Zaldokas, and Yuxiang Zheng, seminar participants at Central University of Finance and Economics, Columbia University, Florida State University, Rutgers University, University of Arizona, University of Macau, University of Toronto, University of Utah, and conference participants at the NTHU Symposium on Sustainable Finance and Economics and HEC-HKUST Sustainable Finance seminar. We thank excellent research support from McKenna Carpenter, Jianqiang Chen, Gen Li, Huayi Tang, and Chi-Yang Tsou. Li acknowledges financial support from the Canada Research Chair in Corporate Governance, the Social Sciences and Humanities Research Council of Canada (Grant Number: 435-2022-0285), and the Montalbano Centre for Responsible Leadership Development at UBC Sauder School of Business. All errors are our own.

"Boards with a diverse mix of genders, ethnicities, career experiences, and ways of thinking have, as a result, a more diverse and aware mindset. They are less likely to succumb to groupthink or miss new threats to a company's business model. And they are better able to identify opportunities that promote long-term growth."

– Blackrock CEO Larry Fink's Annual Letter to CEOs, January 19, 2018

"…a 'eco gender gap' revealing that men are less likely to pursue environmentally-friendly behaviors than their female counterparts."

– Jack Duckett, Senior Consumer Lifestyles Analyst at Mintel, July 27, 2018

1. Introduction

Despite increasing attention and scrutiny from policy makers, regulators, and institutional investors regarding gender diversity in boardrooms, as of 2020, only 28% of board directors are female in the U.S. (Catalyst 2021). Ten European countries have responded to lack of gender diversity in boardrooms by adopting mandatory quotas since 2003. On September 30, 2018, California became the first U.S. state to set quotas for female directors on corporate boards (Senate Bill 826 2018). A number of studies document negative price reactions to affected firms in California, suggesting short-run shareholder value loss (Greene, Intintoli, and Kahle 2020; Hwang, Shivdasani, and Simintzi 2021; Meyerinck, Niessen-Ruenzi, Schmid, and Solomon 2021; Gertsberg, Mollerstrom, and Pagel 2022). In this paper, we study the potential benefit of board gender diversity beyond short-term stock market reactions—in particular, whether and how board gender diversity influences corporate environmental performance, using firm- and facility-level environmental performance measures combined with a rich set of board/director characteristics for over 3,100 firms over the period 2002–2021.

Corporate environmental performance, similar to investments in intangible assets, is characterized by a prolonged period of resource commitment, and generates positive externalities to stakeholders, community, and environment in general. Our conceptual framework builds on a number of well-established gender differences in values and psychological traits that have implications for corporate decision making related to environmental performance. These include gender differences in social (other-regarding) preferences (e.g., benevolence and universalism) and in long-term orientation (Silverman 2003; Schwartz and Rubel 2005; Croson and Gneezy 2009; Castillo, Ferraro, Jordan, and Petrie 2011; Adams and Funk 2012). Consistent with these gender differences in values, a 2019 PwC survey of more than 700 public company directors finds that 71% of the surveyed female directors support a broader stakeholder model of governance compared to 54% of the surveyed male directors. Taken together, we expect that having more women on boards will bring broader and more diverse perspectives to allow the board to better assess the needs of different stakeholders, which helps improve corporate environmental performance.

On the flip side, Adams and Funk (2012) and Lewellen (2022) provide evidence suggesting that self-selection and professional expertise reduce, or even eliminate, some gender differences in preferences and psychological characteristics (e.g., risk-taking preferences). Rose and Bielby (2011) argue that the inclusion of women and visible minorities on corporate boards is symbolic without real consequences. Galbreath (2011) further notes that male directors' sex-based biases and stereotyping could make them discount inputs from female directors on environmental issues. Therefore, it is an empirical question if female directors could indeed help improve corporate environmental performance.

Using Refinitiv's environmental score (and its three component scores) to capture corporate environmental performance over the period 2002–2021 and the share of female directors on a board (from BoardEx) to capture board gender diversity, we first show that there is a positive and significant association between board gender diversity and corporate environmental performance. Our main findings remain when controlling for the share of female top executives, the average age of male independent directors, and the average age of top executives.

To establish the causal effect of female directors on corporate environmental performance, we take a multi-pronged approach. First, we include firm fixed effects to control for time invariant differences across firms that could be correlated with both the share of female directors and corporate environmental performance. Second, we employ the instrumental variables approach. Following Huang and Kisgen (2013) and Field, Souther, and Yore (2020), we use two instruments for the share of female directors in a firm that capture the cross-sectional variation in opportunities for women in states where directors went to college and the temporal variation in discrimination against women when directors were college age. The first instrument is the state-level Gender Equality Index constructed in the late 1970s/early 1980s (Sugarman and Straus 1988) capturing the attainments of women relative to men, in various economic, political, and legal areas. The second one exploits the passage of the Civil Rights Act of 1964, which makes it illegal for college admission to discriminate based on gender or race. Third, we take advantage of the 2018 law change in California that mandated female directors for public firms headquartered in California and employ a difference-in-differences specification, comparing changes in environmental performance between treated Californian firms and a matched control sample outside California (or an alternative control sample of Californian firms already having female directors), to help establish the causal effect of board gender diversity on corporate environmental performance.

Given that corporate environmental ratings by various data providers could differ (Berg, Koelbel, and Rigobon 2022), we employ facility-level data from the Toxic Release Inventory (TRI) database of the U.S. Environmental Protection Agency (EPA) to construct alternative measures of corporate environmental performance. The TRI database covers both pollution prevention activities and production of toxic chemicals at the facility-year level.

Both measures are less subject to the common criticism associated with corporate environmental ratings.

Our facility-level analysis suggests that more female directors are associated with more pollution prevention activities and a lower amount of toxic pollutants produced. Such associations hold when we control for facility- and firm-level characteristics, facility fixed effects, firm industry times year fixed effects, facility industry times year fixed effects, firm headquarters state times year fixed effects, and facility state times year fixed effects. These results support our hypothesis that firms with more female directors take more actions in preventing toxic emissions and thus effectively reduce industrial pollution, and provide micro-evidence for the effect of female directors on corporate environmental performance.

We next explore potential channels through which board gender diversity helps enhance corporate environmental performance. Motivated by the literature on gender differences in values, expertise, professional experience, and monitoring roles (see, for example, Hillman, Cannella, and Harris 2002; Eagly, Johannesen-Schmidt, and van Engen 2003; Schwartz and Rubel 2005; Adams and Ferreira 2009; Kim and Starks 2016), we posit that board gender diversity affects corporate environmental performance through three non-mutually exclusive channels: 1) Female directors bring more expertise on sustainability in boardrooms than male directors; 2) Female directors are more likely to sit on sustainability and key monitoring committees than male directors; and 3) Boards with more female directors are more likely to link top executives' compensation to corporate environmental, social, and governance (ESG) performance.

Using director- and board-level data from the BoardEx data set supplemented by the Refinitiv ESG Board Member data set over the period 2001–2020, we first show that in the same firm-year, compared to male directors, female directors are younger, have shorter board tenure, are more highly educated, and are more likely to have expertise outside industry and not related to finance. These results suggest that having female directors in boardrooms bring fresh perspectives. We further show that in the same firm-year, compared to male directors, female directors are more likely to sit on sustainability-related committees if there is one, and on key monitoring committees. Finally, we show that firms with greater board gender diversity are more likely to link executive pay to corporate ESG performance, more likely to have an ESG (executive) committee, and more likely to disclose ESG information. These results provide corroborative evidence for the role of female directors in influencing corporate environmental performance.

We conduct a number of robustness checks on our main findings. First, including alternative fixed effects to control for local economic conditions and/or state-level regulatory environments such as firm headquarters state times year fixed effects and firm incorporation state times year fixed effects, we show that our main findings remain. Second, we show that there is a critical mass effect in our main findings whereby only having more than one female director is positively and significantly associated with corporate environmental performance. Third, controlling for a board's national cultural values based on each director's country of origin or a board's political leaning based on each director's political donation history does not change our main findings, reinforcing the importance of *gender* diversity in determining environmental outcomes. Finally, using alternative environmental ratings from KLD and ASSET4, we show that our main findings remain.

Our paper makes the following contributions to the literature. First, we add new evidence on the real benefit of having a gender diverse board by focusing on corporate environmental performance, complementing existing literature on various short-run and long-run implications of board gender diversity (see, for example, Ahern and Dittmar 2012; Matsa and Miller 2013; Bertrand, Black, Jensen, and Lleras-Muney 2019; Griffin, Li, and Xu 2021; Eckbo, Nygaard, and Thorburn 2022). Our facility-level analysis also provides micro-evidence that firms with more female directors take more actions in preventing pollution and cutting production of toxic chemicals, effectively reducing industrial pollution. More broadly, our results highlight the importance of corporate leaders' social attitudes in affecting stakeholder outcomes.

Second, we propose and test potential channels through which board gender diversity affects corporate environmental performance. We provide evidence suggesting that board gender diversity influences corporate environmental performance through both their advising and monitoring roles. Thus, our evidence adds to the literature on whether and how directors' personal traits and professional backgrounds help fulfill their duties on boards (see, for example, Adams and Ferreira 2009; Adams and Funk 2012; Kim and Starks 2016; Adams, Akyol, and Verwijmeren 2018; Ginglinger and Genteet-Raskopf 2021; Hwang, Shivdasani, and Simintzi 2021).

Third, we highlight important complementarity among the three pillars of ESG. While the popular press and most of the academic literature take improving corporate ESG policies and practices as the ultimate goal, less attention has been paid to the potential positive externalities among the three pillars. Our results suggest that policies targeting at social issues (e.g., improving board diversity) could have spillover effects on corporate environmental performance, potentially through board governance. Our paper thus complements Flammer, Hong, and Minor (2019), Bolton, Kacperczyk, and Wiedemann (2022), and Dyck, Lins, Roth, Towner, and Wagner (2023) who show that executive compensation design and female directors could be important channels through which investors' preferences for sustainability are materialized in better corporate environmental performance.

2. Literature Review and Hypothesis Development

Our conceptual framework builds on a number of well-established gender differences in personal values and psychological traits that have implications for corporate decision making related to environmental performance.

Across cultures, Schwartz and Rubel (2005) find that men consistently attribute more importance to self-enhancement values (achievement and power), whereas women emphasize self-transcendence values (universalism and benevolence). These gender differences in personal values are also confirmed in a sample of Swedish directors by Adams and Funk (2012). Relatedly, experimental and survey evidence in psychology indicates that women, on average, are more patient than men when trading off present versus future values (Silverman 2003; Castillo et al. 2011). As such, male directors may be more short-term oriented and shareholder focused in their approach to corporate strategy, whereas female directors may be willing to bear the higher costs and focus more broadly on a wide range of stakeholders with a longer-term outlook.

Prior literature on the real effects of female leadership mainly focuses on labor market-related outcomes that could have direct cash flow consequence for a firm.[1] Corporate environmental performance is more related to benefits to external constituents, thus could be more directly shaped by female directors' social preferences compared to corporate labor force-related outcomes.

Consistent with these gender differences in personal values and psychological traits, the PwC's 2019 survey of over 700 public company directors finds that 71% of the surveyed female directors support a broader stakeholder model of governance compared to 54% of the surveyed male directors. In addition, 62% of female directors agree that ESG issues have a

[1] Using plant-level data in the U.S., Tate and Yang (2015) study the impact of plant closures on workers and find that female workers experience a lower likelihood of job separation and a smaller pay cut at hiring firms with female leadership compared to their counterparts at hiring firms with male leadership. Using board gender quota introduced in Norway in 2003 as an exogenous shock to board gender diversity, a number of papers examine its financial (Ahern and Dittmar 2012; Eckbo, Nygaard, and Thorburn 2022) and general labor market implications (Matsa and Miller 2013; Bertrand, Black, Jensen, and Lleras-Muney 2019).

financial impact on long-term company performance, compared to just 45% of male directors.[2]

Taken together, we expect that having more women on boards would encourage more open discussions among directors, and bring broader and more diverse perspectives to allow boards to better assess the needs of different stakeholders, improving corporate environmental performance.

On the flip side, Adams and Funk (2012) and Lewellen (2022) provide evidence suggesting that self-selection and professional expertise reduce, or even eliminate, gender differences in personal values and psychological characteristics, especially in terms of risk attitudes.[3] Rose and Bielby (2011) argue that the inclusion of women and visible minorities on corporate boards is symbolic to manage corporate image and external relations without real consequences. Galbreath (2011) further notes that sex-based biases and stereotyping could exist in boardrooms dominated by male directors who discount inputs from female directors on environmental issues. Using the universe of firms with coverage in Compustat/ExecuComp/BoardEx/RiskMetrics (now the Institutional Shareholder Services) over the period 2006–2017, Field, Souther, and Yore (2020) find that female and minority directors are significantly less likely to serve in leadership positions on a board despite possessing stronger qualifications than non-diverse directors. In the context of California law change, Hwang, Shivdasani, and Simintzi (2021) find that female directors appointed to meet the quota are given fewer board committee responsibilities compared to non-Californian firms, despite similar skill sets. Ultimately, the effect of female directors on corporate

[2] See PwC's 2019 Annual Corporate Directors Survey at: http://www.circulodedirectores.org/wp-content/uploads/2019/12/pwc-2019-annual-corporate-directors-survey-full-report-v2.pdf

[3] Adams and Funk (2012) find that female directors emphasize benevolence more, but are less power or accomplishment oriented. Moreover, in contrast to findings for the population, they find that female directors are less tradition and security oriented and more risk loving than male directors. Lewellen (2022) finds no evidence that gender differences in preferences for risk or altruism affect decision making of hospital CEOs.

environment performance, along with the economic channels for it, could be an empirical question.

Using French data, Ginglinger and Genteet-Raskopf (2021) examine the effect of women on boards on firms' environmental and social (E&S) performance. In contrast, we focus on U.S. firms that are less subject to ESG regulations compared to their European counterparts, and are used as control firms in Ginglinger and Genteet-Raskopf (2021). Moreover, we employ facility-level data to provide micro-level evidence on the effect of female directors on corporate environmental performance. Finally, we explore both within and across firm variations in the share of female directors to help establish its causal effect on corporate environmental performance.

In terms of channels, Adams and Ferreira (2009) show that female directors are more diligent in their roles by having better board attendance than male directors, and that female directors engage in more monitoring than male directors do by sitting on key committees such as audit, nomination, and corporate governance committees. Hillman, Cannella, and Harris (2002) note that male directors tend to have more leadership experience in large corporations, whereas female directors tend to have more experience in community and service organizations. These differences in career trajectories may lead male directors to be more attuned to traditional practices and policies whereas female directors may be more attuned to policies focusing on outreach and community. Kim and Starks (2016) further show that female directors possess more skills than male directors, and that female directors bring unique skills to boards such as sustainability and human resources. The quality and diverse expertise that women bring to boards may also provide better oversight of management activities because of increased heterogeneity among members of a board, with top managers, especially in the environmental dimension given gender differences in values. Flammer, Hong, and Minor (2019) find that the integration of corporate social responsibility (CSR) criteria in executive compensation helps direct management's attention to social and environmental initiatives, resulting in a reduction in toxic emissions.

In summary, we hypothesize that there could be a number of non-mutually exclusive channels through which female directors help enhance corporate environment performance. For example, female directors could bring more expertise on sustainability in boardrooms than male directors, could be more likely to sit on sustainability-related committees and key monitoring committees than male directors, and/or boards with more female directors could be more likely to link top executives' compensation to corporate ESG performance.

3. Data and Sample Formation

3.1. Firm-level data

We employ a number of data sources to measure corporate environmental performance. Our primary data source is Refinitiv, a wholly-owned subsidiary of the London Stock Exchange Group (LSEG), which produces one of the most comprehensive ESG databases. The Refinitiv database covers over 80% of the global market capitalization including most of the key global index constituent firms, about more than 12,000 public and private companies globally. It has a history dating back to 2002, and has been used in recent ESG studies (e.g., Dai, Liang, and Ng 2021; Li, Liu, Mai, and Zhang 2021; Dyck et al. 2023). Refinitiv's ESG score consists of more than 630 data items that span most common environmental, social, and governance issues (Refinitiv 2022).

We focus on the emissions reduction score, innovation score, and resource use score under Refinitiv's environmental pillar to measure corporate environmental performance over the period 2002–2021.[4] These scores range from 0 to 1. A high score reflects a firm's good

[4] The emissions reduction score measures a firm's commitment and effectiveness towards reducing environmental emissions in its production and operational processes. The resource use score reflects a firm's performance and capacity to reduce the use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management. The innovation score reflects a firm's capacity to reduce the

performance in a specific dimension captured by the measure. We use the average across these three scores to capture a firm's overall performance (*E score*).

As robustness checks, we also employ two other data sets from KLD and ASSET4, as alternative measures of corporate environmental performance. To capture a firm's overall environmental performance, we use the scaled strength score minus the scaled concern score under KLD's environmental dimension.[5] The sample period for the KLD data is from 2002 to 2017. With the ASSET4 data, we focus on a company's overall environmental score (ENVSCORE) that is based on three component scores: emissions reduction (ENER), product innovation (ENPI), and resource reduction (ENRR).[6] The sample period for the ASSET4 data is from 2002 to 2018.

Our board and director data mainly come from BoardEx, which contains information such as board composition, committee composition, and biographic information of directors for more than 20,000 companies since 1999. The data coverage is more comprehensive after 2000 which determines the beginning of our sample period in 2001. We supplement BoardEx data with board and director data from the Refinitiv ESG Board Member data set.

We collect firms' financial data from Compustat. We calculate the fraction of shares outstanding held by the five institutional investors with the largest holdings using the Thomson Reuters Institutional Holdings (13F) data set. We extract firms' (historical)

---

environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes, or eco-designed products.

[5] We scale the number of strengths (concerns) in each dimension by the total number of strengths (concerns) available in that dimension in that year as the scaled strength (concern) score. We then use the scaled strength score minus the scaled concern score to obtain the performance score in that dimension. For example, suppose there are 4 strengths and 3 concerns in the environmental dimension. If a firm scores 3 in strengths and 2 in concerns, then its performance score is 0.083 (= 3/4 – 2/3).

[6] ENER measures a company's commitment and effectiveness in reducing air emissions, waste, water discharges and spills or its impact on biodiversity. ENPI measures a company's research and development on eco-efficient products or services. ENRR measures a company's ability to reduce the use of materials, energy, or water and to find more eco-efficient solutions by improving supply chain management. The detailed description is provided in ASSET4 ESG Data Glossary (2013 version). It is worth noting that the ASSET4 data set is different from the Refinitiv data set and is no longer active, as shown in Appendix IA1 in the Internet Appendix.

headquarters states and industry classifications (based on the Standard Industry Classification (SIC) codes) using the Augmented 10-X Header Data downloaded from Bill McDonald's website.[7]

3.2. Facility-level data

Given the divergence in corporate environmental ratings by various ESG data providers (Berg, Koelbel, and Rigobon 2022), we employ facility-level data on pollution prevention (P2) activities and production of toxic chemicals from the TRI database maintained by the U.S. EPA as our alternative measures of corporate environmental performance. Both measures are based on regulatory reporting and hence not subject to the common criticism associated with corporate environmental ratings that might be subjective in nature. We provide more detailed description of the TRI database in Appendix IA2 in the Internet Appendix. According to the EPA's waste management hierarchy in Appendix IA2, both of our facility-level measures are at the top of the hierarchy, thus are more likely to be visible to corporate boards and to be potentially influenced by female directors.

The EPA requires facilities report their new source reduction practices (with aim to prevent pollution) in File Type 2A of the TRI database every year, that meet the following criteria: (1) in the mining, utility, manufacturing, publishing, hazardous waste, or federal industry; (2) manufacturing, processing, or otherwise using a TRI-listed chemical in quantities above certain threshold levels set by the EPA in a given year; and (3) having ten or more full-time equivalent employees. Each facility reports the newly implemented source reduction practices by choosing one or more predefined codes (W-codes) that correspond to a specific practice within the following eight categories: raw material modifications, product modifications, cleaning and degreasing, surface preparation and finishing, process

[7] https://sraf.nd.edu/data/augmented-10-x-header-data/

modifications, spill and leak prevention, inventory control, and good operating practices. Each facility is also required to specify which toxic chemical's production is reduced due to the source reduction practice it implements. Prior literature uses the number of these practices to capture facility-level initiatives to prevent pollution at the annual frequency (Akey and Appel 2021; Bellon 2022).

We employ two facility-level pollution prevention measures in a year: (i) *#Source reduction practices by chemical* denotes the total number of a facility's source reduction practices weighted by the number of toxic chemicals to which a specific practice is applied; and (ii) *#Source reduction practices by facility* denotes the total number of a facility's unique source reduction practices applied to different toxic chemicals. For example, if a facility implements two source reduction practices W1 and W2 in a year (both W1 and W2 are applied to toxic chemicals A and B, and W2 is also applied to toxic chemical Z), then the facility's *#Source reduction practices by chemical* is 5 and its *#Source reduction practices by facility* is 2.

The EPA also requires eligible facilities report their production and management of 775 toxic chemicals in 33 chemical categories (as of August 2022).[8] The TRI database contains the amount of chemical pollutants (in pounds) produced, released, and their names.[9] We use the total quantity of all TRI-listed toxic chemicals produced by a facility to measure its industrial pollution (and as an inverse measure of its environmental performance, see, for example, Li and Zhou 2017; Hsu, Li, and Tsou 2022).[10]

[8] In our facility sample, 7.7% of facility-year observations do not report production wastes.
[9] For the detailed list, please refer to https://www.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals. The Office of Inspector General, an independent office within the EPA, performs audits, evaluations, and investigations of the EPA and its contractors to prevent and detect fraud, waste, and abuse. In addition, the EPA regularly implements an extensive quality analysis of the TRI reporting data and offers analytical support for enforcement efforts led by its Office of Enforcement and Compliance Assurance (OECA).
[10] We provide some additional information about the TRI database in Appendix IA2 in the Internet Appendix. Also see: https://www.epa.gov/toxics-release-inventory-tri-program/common-tri-terms.

We obtain the following facility-level variables from the National Establishment Time-Series (NETS) database (2020 version): facility-level SIC code, estimated sales or revenue created, the number of employees hired, and credit score, which allow us to control for a facility's scale and operating/financial condition.[11]

3.3. Sample overview

Table 1 Panel A lists the steps taken and filters applied to form our main sample of 21,728 firm-year observations for a sample of 3,198 firms over the period 2002–2021. Panel B lists the steps taken to form our facility-level sample of 48,595 facility-year observations for a sample of 4,699 facilities associated with 627 firms over the period 2002–2021. Detailed variable definitions are provided in the Appendix.

Table 2 Panel A presents the summary statistics for the firm sample. In terms of corporate environmental performance, the average *E score* is 0.211, and the average emissions reduction, innovation, and resource use scores are 0.241, 0.148, and 0.245, respectively. Over our sample period, the average share of female directors is 15%, the average board size is 11 directors, and the average share of independent directors is 76%. The average share of female CEOs is about 4%.

Figure 1 plots the temporal trend in the share of female directors over the sample period 2001–2020. Consistent with the increasing attention and scrutiny from policy makers, regulators, and institutional shareholders regarding gender diversity in boardrooms, there is a clear upward trend in the share of female directors over the sample period, ranging from about 10% in early 2000s to over 20% by the end of the sample period, and the rise in the female director share is steeper than before since 2017 when the three largest asset managers

[11] The TRI database offers the crosswalk between TRIFD and dunsnumber, which allows us to merge two datasets. For more details about the NETS database, please refer to https://maryannfeldman.web.unc.edu/data-sources/longitudinal-databases/national-establishment-time-series-nets/.

– State Street, BlackRock, and Vanguard – adopted a policy initiative to require at least one female director on every board of their portfolio firms (Gormley et al. 2021).

Table 2 Panel B presents the correlation matrix for the firm sample. We show that there is a positive and significant correlation between the share of female directors and *E score*. Examination of the correlation matrix more generally suggests multicollinearity is unlikely to be an issue. Given that omitted variable bias in univariate correlations can mask the true relations between the variables, we employ multiple regressions in next section to examine the factors associated with corporate environmental performance.

Table 2 Panel C presents the summary statistics for the facility sample. We show that facilities in our sample on average adopt 0.190 unique pollution reduction practices (and 0.348 weighted by the number of toxic chemicals applicable) and generate 1.269 million pounds of pollutants.

4. Female Directors and Corporate Environmental Performance

4.1. Baseline results

To examine the relation between the share of female directors on a board and corporate environmental performance, we start with the following lead-lag panel data regression specification:

$$
\begin{aligned}
&E\ performance\ measure_{it} \\
&\qquad = \alpha_0 + \alpha_1 Female\ director\ ratio_{it-1} \\
&\qquad + \alpha_2 Governance\ characteristics_{it-1} + \alpha_2 Firm\ characteristics_{it-1} \\
&\qquad + Industry \times Year\ FE \\
&\qquad + \varepsilon_{it}, \qquad (1)
\end{aligned}
$$

where the dependent variables are *E score* and its three component scores provided by Refinitiv. The control variables include other governance characteristics (board size, share of independent directors, share of busy directors, female CEO, and ownership by the top five institutional investors) and firm characteristics (e.g., M/B, firm size, and ROA).[12] Our variable of interest is *Female director ratio.* The choice of our control variables largely follows prior work (e.g., Starks, Venkat, and Zhu 2020; Dyck et al. 2019, 2023). We include (three-digit SIC) industry times year fixed effects to control for industry-specific time-trends in both the share of female directors and corporate environmental performance. Standard errors are clustered at the firm level to account for possible intertemporal dependence in a firm's environmental scores.

Table 3 reports the regression results using the specification in Equation (1), with different environmental scores in different columns. We show that the coefficients on *Female director ratio* are positive and significant in all columns. In terms of economic significance, a one-standard-deviation increase in *Female director ratio* is associated with an increase of 0.024 (= 0.222 × 0.107) in *E score*, about 9.4% of its standard deviation (11% of its mean). The economic magnitude of the effect of female directors on *Emissions reduction score* is similar to that on *Resource use score,* whereas the economic magnitude of the effect of female directors on *Innovation score* is only half that on *Emissions reduction score* or *Resource use score*.

Table IA1 in the Internet Appendix shows that our main findings remain when controlling for the share of female top executives, the average age of male independent directors on a board, and the average age of top executives. The number of observations in analysis is limited by the coverage of ExecuComp.

However, several hard-to-measure omitted variables could potentially bias our OLS estimates above in either direction. On the one hand, the management literature highlights the

[12] There is an on-going debate about the effectiveness of various governance measures in various contexts. It is worth noting that our main findings remain when using an alternative measure of shareholder governance, i.e., the total ownership by Big Three (State Street, Blackrock, and Vanguard) instead of that by a firm's top five institutional investors with the largest holdings.

phenomenon of glass cliff—women and minorities are more likely to take leadership positions in struggling firms (e.g., Ryan and Haslam 2007). If failing firms likely have poor environmental performance (i.e., firms in crises are positively correlated with *Female director ratio*, and negatively correlated with *E score*), then not properly controlling for this firm characteristic will lead to a downward bias in the OLS estimates of the coefficient on *Female director ratio*. On the other hand, if a firm's strategic position on ESG issues is positively correlates with its position on board gender diversity (i.e., a firm's corporate vision is positively correlated with both *Female director ratio* and *E score*), then not properly controlling for it will lead to an upward bias in the OLS estimates of the coefficient on *Female director ratio*.

To establish the causal effect of female directors on corporate environmental performance, we employ several strategies. First, we examine within-firm temporal variations in the share of female directors in relation to within-firm temporal variations in corporate environmental performance by controlling for firm fixed effects. Second, we use the instrumental variables approach. Our two instruments capture cross-sectional variations in opportunities for women in states where directors went to college and temporal variations in discrimination against women when directors were college age, thus providing exogenous cross-sectional variations in the share of female directors on a board. Third, we take advantage of the board gender quota mandated by California's Senate Bill (SB) 826 in 2018 and employ a difference-in-differences specification to examine changes in the environmental performance of Californian firms subject to this regulation, versus changes in that of similar firms headquartered outside California not subject to this regulation, around the passage of SB 826.

4.2. Addressing endogeneity by controlling for firm fixed effects

In this subsection, we examine within-firm temporal variations in the share of female directors in relation to within-firm temporal variations in corporate environmental performance by controlling for firm fixed effects in Equation (1). Table 4 presents the results.

After controlling for potential time-invariant determinants of both the share of female directors and corporate environmental performance, for example, a firm's corporate vision related to ESG issues or stakeholder orientation, we show that *Female director ratio* is still positively and significantly correlated with *E score* and two of its three component scores: *Emissions reduction score* and *Resource use score.*

We note that with firm fixed effects, the magnitude of the effect of female directors becomes much smaller though, generally about one third of that in the specification without firm fixed effects (see Table 3), suggesting that some time-invariant factors such as a firm's strategic position on ESG and/or its stakeholder orientation are likely associated with both its share of female directors and its environmental performance. At the same time, because the variation in our key variable of interest, *Female director share,* largely comes from across firms (instead of from within-firm over time), firm fixed effects regressions, which rely on within-firm temporal variations, might under-estimate the true effect of *Female director share* on corporate environmental performance. Such issue has been raised in prior studies involving slowly changing explanatory variables (Zhou 2001; Hall, Jaffe, and Trajtenberg 2005).

In summary, while including firm fixed effects enhances identification, it may underestimate the effect of female directors by only focusing on within-firm variations in *Female director share*. Next, we consider cross-firm variations in *Female director share*.

4.3. Identification using the instrumental variables approach

Following Huang and Kisgen (2013) and Field, Souther, and Yore (2020), we use two instruments that aim to capture exogenous variations in female representation on corporate boards. The first instrument, *Gender Equality Index (GEI)*, is the historic Gender Equality Index of a state where a director obtained her undergraduate degree. The index assesses "the extent to which women have the same access to economic resources, legal rights, or positions of political power as men" (Sugarman and Straus 1988, p. 234). Sugarman and Straus (1988) construct the index using data from the State and Regional Indicators Archive over the period 1977−1983, when many of our sample directors would have begun their career. The second instrument, *Affirmative Action*, takes the value of one if a director was 18 years old or younger when the Civil Rights Act of 1964 was passed. The Act makes it illegal for college admission to discriminate based on gender or race, thus improves higher education opportunities and job mobility for women and minorities reaching college age after the Act's passage. At the director-year level, these instruments satisfy the relevance condition by influencing the likelihood of observing women becoming directors at a particular firm. The combination of the cross-sectional variation in the *Gender Equality Index* and the temporal variation in the indicator *Affirmative Action* also makes it hard to argue that there is any alternative channel through which these two instruments affects corporate environmental performance, other than through *Female director ratio* (the exclusion restriction).[13]

Given that our primary analysis is at the firm-year level, for each instrument, we calculate the firm-year average across all directors on a board. Table 5 presents the results from the instrumental variables (IV) approach. Column (1) tabulates the first-stage regression results, and confirms that both are valid and strong instruments for *Female director ratio*.

[13] One concern about our Civil Rights Act-related instrument, *Affirmative Action*, is that in a nutshell, it could be a proxy for director (young) age and hence young directors' more positive attitude towards ESG issues. However, the *GEI*-related instrument is less likely to be subject to such concern, given its cross-sectional nature. Nonetheless, Table IA2 in the Internet Appendix shows that our main findings remain when controlling for the average age of male independent directors on a board and the average age of top executives, in both stages of the 2SLS regressions. In the first stage, we note that the average age of male independent directors is positively and significantly associated with the share of female directors. By controlling for the average male independent director age and the average top executive age in the second stage, we address the concern that our main findings are unlikely driven by (young) directors or top executives.

The first-stage F-statistic at 38 is far larger than 10, the conventional cutoff for weak instruments.

Columns (2) to (5) tabulate the second-stage regression results. We note that we fail to reject the overidentification (Hansen's J) test, consistent with our argument that the instruments are valid statistically. Similar to the OLS regression results in Table 3, we show that *Female director ratio* is positively and significantly related to *E score* and its three component scores. The IV estimates of the coefficient on *Female director ratio* are larger than those OLS estimates, but still within the same order of magnitude, which could be due to the fact that our instruments are less subject to the omitted variable bias associated with the existence of a "glass cliff", as laid out in Section 4.1.

In summary, either including firm fixed effects or using the instrumental variables approach, we find consistent results that more female directors help improve corporate environmental performance.

4.4. Identification using the 2018 California SB 826

To further establish the causal effect of female directors on corporate environmental performance, we take advantage of a mandate to increase female representation on boards, California's SB 826, the first mandate in the U.S. that imposes a female director quota on corporate boards. Signed into law on September 30, 2018, it required public companies headquartered in California to have at least one female director by the end of 2019, and depending on board size, some firms were required to have multiple female directors by the end of 2021.

We employ a difference-in-differences (DID) specification to examine changes in both the share of female directors and corporate environmental performance between treated and control firms around the enactment of SB 826 in 2018. Our three-year pre-event window is from 2015 to 2017, and three-year post-event window is from 2019 to 2021. The treated firms are public firms without a female director in 2018 and headquartered (and stayed) in California. To find control firms, we first search for public firms headquartered outside California without a female director in 2018. For each treated firm, we then find a control firm that is in the same (three-digit SIC) industry, and has the smallest total (normalized) absolute difference in total assets and *E score* in 2018 to the treated firm.[14] We end up with 50 treated firms and their matched controls, after the above steps, spanning a number of industries (e.g., pharmaceutical, electronic components, real estate, and business services).

Table IA3 Panel A in the Internet Appendix tabulates the average values of *Female director ratio* and *E score,* for the treated and control firms, in the time period before and after the California law change. These summary statistics could be viewed as the simplest DID analysis without any control variables, and show that the treated and control firms have similar shares of female directors as well as similar environmental performance in the period before the law change. However, these values diverge between the treated and control firms after the law change.

Table 6 Panel A presents the sanity check – the impact of the California law change on the share of female directors in the treated firms compared to that in the control firms. In column (1), we regress *Female director ratio* on *Treated* × *Post*, an interaction term between the indicator variable *Treated* and the indicator variable, *Post*, for the post-event window (from 2019 to 2021). As before, we control for other governance measures and firm characteristics, as well as industry times year fixed effects and firm fixed effects. These fixed effects absorb the standalone indicator variables *Treated* and *Post*. We cluster standard errors in this DID specification by firms' headquarters states, since this is the level at which

[14] To pick control firms, we proceed as follows. First, for each treated firm, we identify all potential control firms that are in the same size quartile and *E score* quartile with the same three-digit SIC code as the treated firm in 2018. Second, for each possible control firm, we compute the absolute size (*E score*) difference between the control and treated firms, and normalize the difference by the standard deviation of the difference across all possible treated-control pairs. Third, we add up the two normalized differences and pick a control firm with the smallest total (normalized) difference in both size and *E score* to the treated firm.

treatment is assigned and cross-firm dependence in the error term may occur (e.g., Bertrand, Duflo, and Mullainathan 2004; MacKinnon, Nielsen, and Webb 2022). We show that the coefficient on the interaction term *Treated* × *Post* is positive and significant, suggesting that the treated firms significantly increase their shares of female directors relative to the control firms, once the mandate is enacted. In column (2), we employ a dynamic DID specification, by interacting *Treated* with the year indicators for each year within the event window examined. The omitted baseline interaction term is *Treated* × *Year 2018*. The coefficients on the first three interactions (from 2015 to 2017) confirm what we find using summary statistics (see Table IA3 Panel A in the Internet Appendix) that before the mandate, both the treated and control firms have very few female directors. After California enacted the mandate, we show that the gap between the two groups in *Female director ratio* grows wider over time.

Panel B presents the DID analysis using the environmental scores as the dependent variables. In column (1), we regress *E score* on *Treated* × *Post*, and find a positive and significant coefficient, suggesting that the increase in the number of female directors mandated by SB 826 leads to better environmental performance of the treated firms in California, compared to the control firms outside California, once the mandate is in effect. The dynamic DID specification in column (2) confirms that there are similar levels of *E score* and temporal trends in *E score* before the mandate, whereas the treated firms exhibit significantly better environmental performance, relative to the control firms, in the post-event period of 2019 to 2021. Interestingly, the DID analysis in columns (3) to (6) suggests that the effect from more female directors mainly comes from the significant improvement in the emissions reduction score. It is possible that total quantity of pollutants produced is the most visible and important dimension of corporate environmental performance, which we will explore further at the facility level, in Section 5.[15]

We note that the treated firms in our main DID analysis do not have a single female director before SB 826, despite headquartered in California. That is, despite the general female-friendly attitudes in California (i.e., California has one of the highest *GEI* values) compared to some other states, the treated and matched control firms exhibit similar patterns in the share of female directors and environmental performance before 2018, while they start to diverge since 2019. In other words, the identification strategy in this section focuses on the within-firm temporal change in the share of female directors, thus complements the identification strategy focusing on the cross-sectional variation in the share of female directors in Section 4.3. Moreover, since we control for firm fixed effects in this test, any time invariant differences such as a firm's ESG vision or stakeholder orientation that could be correlated with both the share of female directors and corporate environmental performance are unlikely to be drivers of our main findings. Finally, we do not find any major changes of regulations targeting industrial pollution around SB 826 in California, which mitigates the concern of other confounding regulatory changes driving our results.

Table IA3 Panel C repeats the DID analysis in Table 6 using the same treated firms while control firms are chosen from those headquartered in California with at least two female directors in 2018; as a result, those control firms are not required to add additional female directors. We find the closest control firm for each treated firm by matching on (three-digit SIC) industry, firm size, and *E score* in 2018. We show that the coefficients on the interaction term *Treated* $\times$ *Post* are positive and significantly different from zero, suggesting

[15] Table IA3 Panel B repeats the DID analysis using 2016 as the pseudo event year. We show that the coefficients on the interaction term *Treated* $\times$ *Post* are not significantly different from zero when the dependent variables are *Female director ratio* and *E score*, suggesting that the estimated treatment effects in Table 6 are not random, but attributable to SB 826.

that compared to peer California firms without the pressure to add female directors, the treated firms experience significant increases in *Female director ratio* and *E score* after the enactment of SB 826. We interpret this finding as supporting evidence that the treatment effect is likely driven by an increase in the number of female directors mandated by SB 826, rather than other state-wide regulations in California.[16]

In summary, using different identification strategies and exploring exogenous variations in both the cross-section and time-series of women representation on boards, we conclude that there is a potential causal effect of female directors (as opposed to, for example, other director characteristics) on corporate environmental performance, especially through emissions reduction measures.

5. Female Directors and Facility-level Environmental Performance

Given that ESG ratings by various data providers (Berg, Koelbel, and Rigobon 2022) could be different and contain estimation biases, we employ facility-level data from the EPA that are based on regulatory reporting and hence are not subject to the common criticism associated with ESG ratings, to provide novel micro-level evidence on the positive association between the share of female directors and corporate environmental performance, specifically pollution-related outcomes.

We run the following lead-lag panel data regressions:

[16] This finding remains if we use control firms headquartered in California with at least one female director in 2018.

$$
\begin{aligned}
&Facility-level\ outcome_{jt} \\
&\quad = \alpha_0 + \alpha_1 Female\ director\ ratio_{it-1} + \alpha_2 Facility\ characteristics_{jt-1} \\
&\quad + \alpha_3 Governance\ characteristics_{it-1} + \alpha_4 Firm\ characteristics_{it-1} \\
&\quad + \theta Facility\ FE_j + \gamma_1 Firm\ industry \times Year\ FE \\
&\quad + \gamma_2 Facility\ industry \times Year\ FE \quad + \gamma_3 Firm\ HQ\ state \times Year\ FE \\
&\quad + \gamma_4 Facility\ state \times Year\ FE \quad + \varepsilon_{jt}, \qquad (2)
\end{aligned}
$$

where $Facility-level\ outcome_{jt}$ is the natural logarithm of one plus the value of one of the following three measures of facility *j* of firm *i* in industry *s* in year *t*: 1) facility *j*'s number of source reduction practices weighted by the number of toxic chemicals applicable; 2) facility *j*'s number of unique source reduction practices applied to different toxic chemicals; and 3) facility *j*'s total production waste. Our variable of interest is $Female\ director\ ratio_{it}$, denoting the share of female directors in firm *i* in year *t*. $Facility\ characteristics_{jt}$ include facility *j*'s sales (in logarithm), number of employees (in logarithm), and credit ratings in year *t*. Other control variables are similar to those included in Equation (1) for our firm-year level analysis. We control for facility fixed effects ($Facility\ FE_j$) that absorb facility-level, time-invariant factors. We also control for firm industry times year and facility industry times year fixed effects that absorb industry-specific time trends. We further control for firm headquarters state times year fixed effects and facility state times year fixed effects to absorb time-varying local factors (e.g., economic conditions) related to firms and facilities. We cluster standard errors at the firm level to account for firm-level treatment (i.e., the share of female directors) and possible interdependence within a firm across its facilities in their industrial pollution-related outcomes.

Table 7 presents the results using the regression specification in Equation (2). In Panel A where the dependent variable is the number of source reduction practices weighted by the number of toxic chemicals applicable, we show a positive and significant association between the share of female directors and the number of source reduction practices across different specifications. The coefficients on *Female director ratio* are in the range between 0.203 to 0.217 across different models. In terms of economic significance, using column (4) as an example, an increase from zero to 0.086 (the standard deviation of the female director ratio in the facility-level sample) in *Female director ratio* is associated with an increase of 0.025 in facilities' pollution prevention activities, which corresponds to 7.3% of the sample mean.[17] A similar pattern is found in Panel B based on the number of unique source reduction practices by each facility in a year. We conclude that the share of female directors is positively associated with more corporate initiatives to reduce industrial pollution.

In Panel C where the dependent variable is *Total production waste*, we find that the share of female directors is negatively and significantly associated with the facility-level quantity of production waste across different model specifications. The coefficients on *Female director ratio* range between -0.169 to -0.167. In terms of economic significance, using column (4) as an example, an increase from zero to 0.086 (the standard deviation of the female director ratio in the facility-level sample) in *Female director ratio* is associated with a decrease of 3.2% in facilities' total quantity of production waste, which corresponds to 2.5% of the sample mean.[18]

One concern for the facility-level analysis is that firms may opportunistically relocate some of their most polluting production across facilities to help improve their environmental ratings. Including facility fixed effects in our facility-level regressions helps mitigate this concern. Moreover, our facility-level controls for the scale of a facility in terms of production

[17] When a firm increases its female director ratio from 0 to 0.086, its facility is associated with a 0.025 (= (1 + 0.348) × (exp(0.086 × 0.217) − 1)) increase in its number of pollution prevention activities. Such increase corresponds to 7.3% of the average number of pollution prevention activities (0.348).

[18] When a firm increases its female director ratio from 0 to 0.086, its facility is associated with a –0.032 (= (1 + 1.269) × (exp(0.086 × (–0.167) − 1)) drop in total quantity of production waste produced. Such drop corresponds to 2.5% of the average of total quantity of production waste (1.269).

output and employee headcount help rule out the possibility that a facility's drop in waste production is due to its opportunistic cut of production scale. Our results suggest that there is a positive association between within-facility temporal change (which is the same as within-firm temporal change) in the share of female directors and within-facility temporal improvement in environmental performance as measured by pollution prevention and toxic chemicals produced.

Given the concerns raised by Cohn, Liu, and Wardlaw (2022) about implementing ordinary least squares regression estimation for count-based dependent variables, we also estimate Poisson regressions for Equation (2) when the dependent variables are the two measures of source reduction practices. Table IA4 in the Internet Appendix presents the results. We show that our main findings remain.

In summary, Table 7 based on the EPA's TRI data set provides direct evidence in support of our main findings using firm-level data that firms' environmental performance increases with their share of female directors.

Finally, instead of controlling for location-year fixed effects, we again explore the effect of California's SB 826 on facility-level outcomes for the treated and control firms, defined in Table 6, before versus after the mandate. The sample size is small: we only have data on production waste for 18 facilities of the treated firms, and 32 facilities of the control firms, which limits the analysis.[19] Still, both summary statistics (Panel A) and regression results (Panel B) in Table IA5 in the Internet Appendix suggest that the drop in total production waste in treated facilities from pre- to post-SB 826 is significantly greater than that in control facilities.[20] Again, we control for facility fixed effects, which helps mitigate

[19] Over the estimation window, there is no reported new source reduction practice by either treated firm facilities or control firm facilities.
[20] Results remain similar if we exclude control firms' facilities located in California, suggesting that our results are not driven by other confounding regulatory changes in California.

the concern about Californian firms reallocating facilities to different states after the enactment of SB 826.

6. The Channels

In our hypothesis development, we posit that board gender diversity may affect corporate environmental performance through the following mutually non-exclusive channels: 1) Female directors bring more expertise on sustainability in boardrooms than male directors; 2) Female directors are more likely to sit on sustainability-related committees and key monitoring committees than male directors; and 3) Boards with more female directors are more likely to link CEO compensation to corporate ESG performance. Our director- and board-level data for the channel analysis are primarily from BoardEx, supplemented by the Refinitiv ESG Board Member data set.

Motivated by the literature on director qualifications separated by gender (Hillman, Cannella, and Harris 2002; Kim and Starks 2016; Ginglinger and Genteet-Raskopf 2021; Hwang, Shivdasani, and Simintzi 2021), in Table 8, we examine whether female directors are significantly different from their male counterparts in terms of qualifications, committee roles, and governance roles, using a sample of firm-director-year observations derived from the firm sample in Table 3.

Panel A presents the regression results comparing female and male directors in age, board tenure, and educational background, within a firm-year.[21] We show that in the same firm-year, female directors are significantly younger and have significantly shorter board tenures compared to their male counterparts. We further note that female directors are significantly less likely to study business or STEM compared to their male counterparts,

[21] Table IA6 Panel A in the Internet Appendix presents the two-sample t-test results by director gender.

whereas female directors are significantly more highly educated (in terms of the highest degree achieved) compared to their male counterparts.[22]

Panel B presents the regression results comparing female and male directors in skill sets as well as industry and finance experience.[23] We first show that in the same firm-year, compared to male directors, female directors are more likely to have skills in academic, community, environment/sustainability, government, risk management, and technology, consistent with the findings in Kim and Starks (2016). Moreover, female directors have significantly more skills than male directors. However, we note that female directors are significantly less likely to have finance or same-industry experience (as classified by Refinitiv).

All the above are consistent with our conjecture that female directors bring diverse skill sets and work experiences to corporate boards, facilitate open discussions on timely societal issues (given their relatively younger age and shorter tenures than male directors), thus improving corporate environmental performance.

Motivated by the literature on director monitoring separated by gender (Adams and Ferreira 2009; Field, Souther, and Yore 2020) and well-known gender differences in values and psychological traits, we next examine female directors' roles in influencing corporate environmental activities.

Table 8 Panel C presents the regression results comparing female and male directors in board leadership roles and committee affiliations, controlling for other director characteristics.[24] We first show that female directors are significantly less likely to serve leadership roles on boards (as Chairman of the Board or lead director) compared to their male

[22] Highest degree received by a director takes the value of 3 for PhD, JD, and MD, 2 for MBA and other master's degree, or 1 for bachelor's degree, and zero otherwise.
[23] Table IA6 Panel B in the Internet Appendix presents the two-sample t-test results by director gender.
[24] Table IA6 Panel C in the Internet Appendix presents the two-sample t-test results by director gender. Panel D provides summary statistics for directors' board leadership roles and committee affiliations at the director-year level, and Panel E provides summary statistics for the presence of board key committees at the firm-year level.

counterparts, consistent with prior findings (Field, Souther, and Yore 2020).[25] We further show that across all four key committees on a board: audit, compensation, ESG, and nomination committees, female directors are significantly more likely to serve on all those committees compared to their male counterparts.

Our findings thus far are generally consistent with the findings in Adams and Ferreira (2009) with us using a much recent sample. Importantly, we show that there is a positive and significant association between a director being female and her likelihood to be on the ESG committee, possibility due to her ESG-related personal values, expertise, or experience.

Flammer, Hong, and Minor (2019) show that incentives and disclosure are vital to improve corporate environmental performance. Given gender differences in values, we expect female directors are more likely to support for providing incentives and disclosure related to corporate environmental performance.

At the firm-year level, we obtain data on whether there is compensation policy linking ESG metrics to executive pay, whether there is a ESG committee (either at the executive level or board level), and whether there is ESG reporting, from the Refinitiv ESG data set.[26] Table 8 Panel D presents the regression results using a similar specification as Equation (1) including firm fixed effects. We show that there is a positive and significant association between a firm's *Female director ratio* and its having ESG-linked compensation policy for executives, ESG (executive) committee, and ESG reporting.

We conclude that female directors' expertise and committee affiliations are important channels through which board gender diversity helps improve corporate environmental performance, potentially through both their advising and monitoring roles.

---

[25] In these two specifications, we include firm fixed effects and industry times year fixed effects, instead of firm times year fixed effects, because typically only one director per firm-year takes a leadership position.

[26] Table IA6 Panel F in the Internet Appendix provides summary statistics. We show that about a quarter of the firm-year observations have a compensation policy linking ESG metrics to executive pay. About 28% of the firm-year observations have an ESG (executive) committee. About 28% of the firm-year observations also publish an ESG report.

7. Additional Investigation

7.1. Incorporating different fixed effects

We acknowledge that our baseline results may be affected by time-varying local economic conditions and/or by different state-level laws and regulations. To address these concerns, we further include the following fixed effects in Equation (1): headquarters state times year fixed effects and incorporation state times year fixed effects. The former absorb the effects of local economic conditions related to firms' business operations (including their shares of female directors and environmental performance), and the latter absorb the effects of various state-level laws and regulations related to social and environmental issues.

Table IA7 in the Internet Appendix presents the results. We find that the effect of female director ratio remains statistically significant when including those fixed effects. In the setting with firm and year fixed effects, the coefficient on *Female director ratio* drops from 0.108 in column (1) to 0.104 and 0.080 in columns (2) and (3) that include headquarters state times year fixed effects and incorporation state times year fixed effects, respectively. In the setting with firm and industry times year fixed effects, the coefficient on *Female director ratio* drops from 0.074 in column (1) of Table 4 to 0.071 and 0.061 in columns (4) and (5) that include headquarters state times year fixed effects and incorporation state times year fixed effects, respectively. All these results suggest that our main finding is robust to controlling for local economic conditions and state-level laws and regulations.

7.2. The nonlinear effect of board gender diversity

To examine any possible nonlinear effect of the number of women on a board, we introduce indicator variables representing a board having one or more woman, two or more women, or three or more women.[27] Table IA8 column (1) in the Internet Appendix presents the results. We show that the effect of female directors on corporate environmental performance is only significant when there are more than one female director, highlighting the importance of having a critical mass of female directors.

7.3. Controlling for directors' country of origin and political affiliation

To make sure that our main findings are not driven by directors' cultural heritage or their political affiliation, we additionally control for director cultural heritage at the board level, or a board's political leaning. To determine a director's cultural heritage, we use her last name to infer her ancestral origin, based on historical immigration records (see Pan, Siegel, and Wang (2017, 2020) for more details). For national cultural values, we rely on the well-established national cultural framework developed by Hofstede (1980, 2001). For each director, we obtain her Hofstede cultural values (standardized to be between 0 and 1) based on her country of origin. We then take an average of each cultural value across all directors for a firm-year. To capture a director's political leaning, we collect her political donation data from the Federal Election Commission and compute the share of her total donation to the Democratic party. We then take an average of each director's political leaning across all directors for a firm-year. Table IA8 columns (2)-(5) in the Internet Appendix present the results. It is worth noting that our main findings remain controlling for directors' national culture or political leaning.

7.4. Using alternative corporate environmental performance data

[27] When a firm has three female directors, all three indicator variables "Female director count ≥ 3", "Female director count ≥ 2", and "Female director count ≥ 1" take the value of one. When a firm has two female directors, the indicator variable "Female director count ≥ 3" takes the value of zero, whereas the two other indicator variables "Female director count ≥ 2" and "Female director count ≥ 1" take the value of one. As a result, the indicator variable "Female director count ≥ 3" captures the marginal effect of having three or more female directors at a firm.

To ensure that our baseline results are not driven by some specific features of the Refinitiv data set, we also consider two other commonly used ESG data sources: the KLD and ASSET4 data. The KLD data set assesses a firm's ESG activities using over 80 indicators in seven dimensions that include community, corporate governance, diversity, employee relations, environment, human rights, and product. The ASSET4 data set from Thomson Reuters, consisting of more than 280 data items, is the predecessor to Refinitiv's ESG data set. But Refinitiv has made it clear that these two ESG data sets are based on different methodologies (see Appendix IA1 in the Internet Appendix). Table IA9 in the Internet Appendix presents the results using these two alternative environmental performance measures. We show that our main findings remain.

8. Conclusions

Using firm- and facility-level measures of corporate environmental performance over the period 2002–2021, we establish a robust and positive association between board gender diversity and corporate environmental performance. This relation appears to be causal, based on identification strategies using either the instrumental variables approach, or the California law change in 2018 mandating female directors for firms headquartered in California.

Using granular board- and director-level data, we further establish a number of mutually non-exclusive channels for such effect. We find that female directors bring more expertise on sustainability in boardrooms than male directors. Female directors are more likely to sit on sustainability-related committees and key monitoring committees than male directors. Boards with more female directors are more likely to link top executives' compensation to corporate ESG performance.

We conclude that there are long-term benefits for boards to be gender diverse. Moreover, we establish novel evidence on the important interactions among the three pillars of ESG in this paper: policies targeting at _s_ocial issues (e.g., improving board diversity) could have spillover effects for corporate _e_nvironmental performance, possibly through _g_overnance channels.

Appendix
Variable definitions

All continuous variables are winsorized at the 1st and 99th percentiles.

Variable	Definition	Source
Environmental performance measures		
E score	Average of emissions reduction score, resource use score, and innovation score.	Refinitiv ESG
Emissions reduction score	The emission reduction score measures a firm's commitment and effectiveness towards reducing environmental emissions in its production and operational processes.	Refinitiv ESG
Innovation score	The innovation score reflects a firm's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes or eco-designed products.	Refinitiv ESG
Resource use score	The resource use score reflects a firm's performance and capacity to reduce the use of materials, energy, or water and to find more eco-efficient solutions by improving supply chain management.	Refinitiv ESG
ln(#Source reduction practices by chemical + 1)	Natural logarithm of one plus the total number of a facility's source reduction activities (i.e., activities a facility implements to prevents pollution) applied to each different toxic chemical in a year. For example, if a facility implements two source reduction practices W1 and W2 in a year (both W1 and W2 are applied to toxic chemicals A and B, and W2 is applied to toxic chemical Z), then its *#Source reduction practices* by chemical is 5. The value is collected from TRI File Type 2A Form (more details are provided in the Internet Appendix).	EPA Pollution Prevention (P2)
ln(#Source reduction practices by facility + 1)	Natural logarithm of one plus the total number of a facility's unique source reduction activities (i.e., activities a facility implements to prevents pollution) applied to different toxic chemicals in a year. For example, if a facility implements two source reduction practices W1 and W2 in a year (both W1 and W2 are applied to toxic chemicals A and B, and W2 is applied to toxic chemical Z), then its *#Source reduction practices by facility* is 2. The value is collected from TRI File Type 2A Form (more details are provided in the Internet Appendix).	EPA Pollution Prevention (P2)
ln(Total production waste + 1)	Natural logarithm of one plus a facility's total quantity of toxic chemicals (in millions of pounds) produced in the production process in a year.	EPA TRI
Firm characteristics		

Female director ratio	Number of female directors scaled by board size.	BoardEx
Board size	Number of directors on a board.	BoardEx
Board independence	Number of independent directors scaled by board size.	BoardEx
Board busyness	Number of independent directors with three or more board seats scaled by board size.	BoardEx
Female CEO	Indicator variable that takes the value of one if a firm has a female CEO, and zero otherwise.	BoardEx
Top5 institutions	Fraction of shares outstanding held by the five institutional investors with the largest holdings.	WRDS Thomson 13F
M/B	Market value of equity scaled by book value of equity.	Compustat
Firm size	Natural logarithm of total assets.	Compustat
ROA	Net income after subtracting expenses or losses, including extraordinary items scaled by total assets.	Compustat
Leverage	Sum of long-term debt and debt in current liabilities scaled by total assets.	Compustat
Cash holdings	Cash and short-term investments scaled by total assets.	Compustat
SG&A	Selling, general, and administrative expenses scaled by sales.	Compustat
E score_KLD	Difference between a firm's environmental strength score scaled by the total number of environmental strength score items and its environmental concern score scaled by the total number of environmental concern score items.	KLD
E score_ASSET4	Overall score of a firm's environmental performance based on three component scores: emission reduction, product innovation, and resource reduction.	ASSET4
Female director count ≥ 1	Indicator variable that takes the value of one if a firm has one or more female directors, and zero otherwise.	BoardEx
Female director count ≥ 2	Indicator variable that takes the value of one if a firm has two or more female directors, and zero otherwise.	BoardEx
Female director count ≥ 3	Indicator variable that takes the value of one if a firm has at least three or more female directors, and zero otherwise.	BoardEx
Board IDV (UAI, PDI, MAS)	Average of the individualism (uncertainty avoidance, power distance, or masculinity) score of directors on a board in a year, based on a director's ancestral background inferred from her last name. See Pan, Wang, and Siegel (2017, 2020) for details.	Hofstede Culture Dimension website, Pan, Wang, and Siegel (2017, 2020)

Board Democratic share	Average of the Democratic share of each director on a board in a year. A director k's Democratic share is captured by her contribution amount to the Democratic ($D_{k,\to t}$) and Republican ($R_{k,\to t}$) parties up to year t as follows: $$Dem_{k,t} = \frac{D_{k,\to t}}{R_{k,\to t} + D_{k,\to t}}.$$	Federal Election Commission
Facility characteristics		
Credit score	The maximum Dun & Bradstreet PayDex Score – a 100-point indexing system that captures trade experiences reported to NETS, compares payment to terms of sale, and scores the overall manner of payment. The index is dollar-weighted by the amount of credit involved. A PayDex Score of 80 indicates that on average, a business pays its bills in a "Prompt" manner.	NETS
ln(Sales)	Natural logarithm of estimated sales (in millions of dollars) of a facility in a year.	NETS
ln(#Employees)	Natural logarithm of reported number of employees working in a facility in a year.	NETS
Instrumental variable		
Gender Equality Index	Firm-year average of the Gender Equality Index (GEI) of the state where a director obtained her undergraduate degree. We first assign GEI to each director based on the state where she went to college. We then calculate the firm-year average GEI across all directors on a board in a year. The index includes state-level indicators of economic, political, and legal gender equality. It combines seven economic gender equality (such as labor market participation and labor income), four indicators of political gender equality (such as female representation in state house and as mayors), and thirteen indicators of legal gender equality (such as fair employment practices law and equal pay law), using data from the State and Regional Indicators Archive over the period 1977–1983.	Sugarman and Straus (1988)
Affirmative Action	Firm-year average of the Affirmative Action indicator across all directors on a board in a year. The Affirmative Action indicator takes the value of one if a director was 18 years old or younger in 1965 following the passage of the Civil Rights Act of 1964, and zero otherwise. The Act makes it illegal for college admission to discriminate based on gender or race, providing more higher education opportunities and job mobility for women and minorities.	Field, Souther, and Yore (2020)
Channel variables		
Director-level		

Female	Indicator variable that takes the value of one if a director is a female, and zero otherwise.	BoardEx
Age	Director age.	BoardEx
Tenure	Director tenure.	BoardEx
Field_business	Indicator variable that takes the value of one if a director has earned a degree in economics or business (e.g., MBA, BBA, BCOM, DBA), and zero otherwise.	BoardEx
Field_law	Indicator variable that takes the value of one if a director has earned a degree in law (e.g., JD, LLB, LLM), and zero otherwise.	BoardEx
Field_medicine	Indicator variable that takes the value of one if a director has earned a degree in medicine (e.g., MD), and zero otherwise.	BoardEx
Field_STEM	Indicator variable that takes the value of one if a director has earned a degree in science (e.g., BS, BSc, Bachelor of Engineering, MSc), and zero otherwise.	BoardEx
#Fields	Sum of a director's fields of study.	BoardEx
Highest degree	Highest degree received by a director. It takes the value of 3 for PhD, JD, and MD, 2 for MBA and other master's degree, 1 for bachelor's degree, and zero otherwise.	
Skill_academic	Indicator variable that takes the value of one if a director has worked at universities and her prior job roles contain any of the following key words: professor, lecturer, faculty, instructor, dean, director, chair, provost, chancellor, principal, or president, and zero otherwise.	BoardEx
Skill_community	Indicator variable that takes the value of one if a director has worked at charities, or her prior job roles or job descriptions contain any of the following key words: community, non-profit, nonprofit, philanthropic, social, or CSR, and zero otherwise.	BoardEx
Skill_environment	Indicator variable that takes the value of one if a director has experience in environmental and/or sustainability issues, and zero otherwise. A director has experience in environment if her prior job roles or job descriptions contain any of the following key words: environment, safety, sustainability, sustainable, or ESG.	BoardEx
Skill_government	Indicator variable that takes the value of one if a director has worked at government agencies, or her prior job roles contain any of the following key words such as commissioner, council member, senior advisor, or director, and zero otherwise.	BoardEx
Skill_risk mgt	Indicator variable that takes the value of one if a director has experience in risk management, and zero otherwise. A director has experience in risk management if her prior job roles or job descriptions contain any of the following key words: risk, compliance, litigation, legal, or cyber.	BoardEx

Skill_tech	Indicator variable that takes the value of one if a director has experience in engineering, science, or research and development, and zero otherwise. A director has experience in technology if her prior job roles or job descriptions contain any of the following key words: engineer, scientific, scientist, science, research and development, R&D, R & D, technology, or technological.	BoardEx
#Skills	Sum of a director's skill sets.	BoardEx
Industry experience	Indicator variable that takes the value of one if a director has industry-related experience (to the focal firm), and zero otherwise.	Refinitiv
Finance experience	Indicator variable that takes the value of one if a director has finance and/or accounting experience, and zero otherwise.	Refinitiv
Chairman of the Board	Indicator variable that takes the value of one if a director is Chairman of the Board, and zero otherwise.	BoardEx
Lead director	Indicator variable that takes the value of one if a director's role contains any of the following key words: lead independent director, lead independent chairman, presiding lead independent director, lead independent corporate director, lead independent vice chairman, lead director, vice chairman (lead independent director), or lead independent outside director, and zero otherwise.	BoardEx
Audit committee	Indicator variable that takes the value of one if a director sits on audit committee in a year, and zero otherwise.	BoardEx
Compensation committee	Indicator variable that takes the value of one if a director sits on compensation committee in a year, and zero otherwise.	BoardEx
ESG committee	Indicator variable that takes the value of one if a director sits on ESG committee in a year, and zero otherwise. A board committee is responsible for ESG if its committee name contains any of the following key words: CSR, ESG, environ*, social, or sustain*.	BoardEx
Nomination committee	Indicator variable that takes the value of one if a director sits on nomination committee in a year, and zero otherwise.	BoardEx
Firm-level		
Female top executive ratio	Number of female top executives scaled by the total number of (up to) top 5 executives.	ExecuComp
Average age of male independent directors	Average age of male independent directors on a board.	BoardEx
Average age of top executives	Average age of (up to) top 5 executives.	ExecuComp

Compensation policy including ESG metric	Indicator variable that takes the value of one if a firm has an executive compensation policy that takes into account its ESG performance, and zero otherwise. The data item from Refinitiv is as follows: “Does the company have an extra-financial performance oriented compensation policy? - the compensation policy includes remuneration for the CEO, executive directors, non-board executives, and other management bodies based on ESG or sustainability factors.”	Refinitiv
ESG (executive) committee	Indicator variable that takes the value of one if a firm has an ESG committee at either the board level or at the senior management level, and zero otherwise. The data item from Refinitiv is as follows: “Does the company have a CSR committee or team? - board level or Senior management committee responsible for decision making on CSR strategy.”	Refinitiv
ESG reporting	Indicator variable that takes the value of one if a firm has implemented ESG reporting, and zero otherwise. The data item from Refinitiv is as follows: “Does the company publish a separate CSR/H&S/Sustainability report or publish a section in its annual report on CSR/H&S/Sustainability?”	Refinitiv

References:

Adams, Renée B., Ali C. Akyol, and Patrick Verwijmeren, 2018. Director skill sets, *Journal of Financial Economics* 130, 641–662.

Adams, Renée B., and Daniel Ferreira, 2009. Women in the boardroom and their impact on governance and performance, *Journal of Financial Economics* 94, 291–309.

Adams, Renée B., and Patricia Funk, 2012. Beyond the glass ceiling: Does gender matter? *Management Science* 58, 219–235.

Ahern, Kenneth R., and Amy K. Dittmar, 2012. The changing of the boards: The impact on firm valuation of mandated female board representation, *Quarterly Journal of Economics* 127, 137–197.

Akey, Pat, and Ian Appel, 2021. The limits of limited liability: Evidence from industrial pollution, *Journal of Finance* 76, 5–55.

Bellon, Asymeric, 2022. Fresh start or fresh water: The impact of environmental lender liability, UNC at Chapel Hill working paper.

Berg, Florian, Julian F. Koelbel, and Roberto Rigobon, 2022. Aggregate confusion: The divergence of ESG ratings, *Review of Finance* forthcoming.

Bertrand, Marianne, Sandra E. Black, Sissel Jensen, and Adriana Lleras-Muney, 2019. Breaking the glass ceiling? The effect of board quotas on female labour market outcomes in Norway, *Review of Economic Studies* 86, 191–239.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, 2004. How much should we trust differences-in-differences estimates? *Quarterly Journal of Economics* 119, 249–275.

Bolton, Patrick, Marcin Kacperczyk, and Moritz Wiedemann, 2022. The CO2 question: Technical progress and the climate crisis, Imperial College working paper.

Castillo, Marco, Paul J. Ferraro, Jeffrey L. Jordan, and Ragan Petrie, 2011. The today and tomorrow of kids: Time preferences and educational outcomes of children, *Journal of Public Economics* 95, 1377–1385.

Catalyst, 2021. Women's global representation on boards in selected countries, 2020, available at: https://www.catalyst.org/research/women-on-corporate-boards/ (assessed on October 3, 2022).

Cohn, Jonathan B., Zack Liu, and Malcolm I. Wardlaw, 2022. Count (and count-like) data in finance, *Journal of Financial Economics* 146, 529–551.

Croson, Rachel, and Uri Gneezy, 2009. Gender differences in preferences, *Journal of Economic Literature* 47, 1–27.

Dai, Rui, Hao Liang, and Lilian Ng, 2021. Socially responsible corporate customers, *Journal of Financial Economics* 142, 598–626.

Dyck, Alexander, Karl V. Lins, Lukas Roth, Mitch Towner, and Hannes F. Wagner, 2023. Renewable governance: Good for the environment? *Journal of Accounting Research* 61, 279–327.

Dyck, Alexander, Karl V. Lins, Lukas Roth, and Hannes F. Wagner, 2019. Do institutional investors drive corporate social responsibility? International evidence, *Journal of Financial Economics* 131, 693–714.

Eagly, Alice H., Mary C. Johannesen-Schmidt, and Marloes L. van Engen, 2003. Transformational, transactional, and laissez-faire leadership styles: A meta-analysis comparing women and men, *Psychological Bulletin* 129, 569–591.

Eckbo, B. Espen, Knut Nygaard, and Karin S. Thorburn, 2022. Valuation effects of Norway's board gender-quota law revisited, *Management Science* 68, 4112–4134.

Field, Laura Casares, Matthew E. Souther, and Adam S. Yore, 2020. At the table but cannot break through the glass ceiling: Board leadership positions elude diverse directors, *Journal of Financial Economics* 137, 787–814.

Flammer, Caroline, Bryan Hong, and Dylan Minor, 2019. Corporate governance and the rise of integrating corporate social responsibility criteria in executive compensation: Effectiveness and implications for firm outcomes, *Strategic Management Journal* 40, 1097–1122.

Galbreath, Jeremy, 2011. Are there gender-related influences on corporate sustainability? A study of women on boards of directors, *Journal of Management and Organization* 17, 17–38.

Gertsberg, Marina, Johanna Mollerstrom, and Michaela Pagel, 2022. Gender quotas and support for women in board elections, NBER working paper No. 28463.

Ginglinger, Edith, and Caroline Genteet-Raskopf, 2021. Women directors and E&S performance: Evidence from board gender quotas, Université Paris–Dauphine working paper.

Gormley, Todd A., Vishal K. Gupta, David A. Matsa, Sandra Mortal, and Lukai Yang, 2021. The big three and board gender diversity: The effectiveness of shareholder voice, Washington University in St. Louis working paper.

Greene, Daniel, Vincent J. Intintoli, and Kathleen M. Kahle, 2020. Do board gender quotas affect firm value? Evidence from California Senate Bill No. 826, *Journal of Corporate Finance* 60, 101–121.

Griffin, Dale, Kai Li, and Ting Xu, 2021. Board gender diversity and corporate innovation: International evidence, *Journal of Financial and Quantitative Analysis* 56, 123–154.

Hall, Bronwyn H., Adam Jaffe, and Manuel Trajtenberg, 2005. Market value and patent citations, *RAND Journal of Economics* 36, 16–38.

Hillman, Amy J., Albert A. Cannella, and Ira C. Harris, 2002. Women and racial minorities in the boardroom: How do directors differ? *Journal of Management* 28, 747–763.

Hofstede, Geert H., 1980. *Culture's Consequences: International Differences in Work-related Values*, SAGE Publications, Thousand Oaks, CA.

Hofstede, Geert H., 2011. Dimensionalizing cultures: The Hofstede model in context. Online Readings in Psychology and Culture, 2(1). https://doi.org/10.9707/2307-0919.1014

Hsu, Po-Hsuan, Kai Li, and Chi-Yang Tsou, 2022. The pollution premium, *Journal of Finance* forthcoming.

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

Hwang, Sunwoo, Anil Shivdasani, and Elena Simintzi, 2021. Mandating women on boards: Evidence from the United States, Korea University working paper.

Kim, Daehyun, and Laura T. Starks, 2016. Gender diversity on corporate boards: Do women contribute unique skills? *American Economic Review: Papers & Proceedings* 106, 267–271.

Lewellen, Katharina, 2022. Women in charge: Evidence from hospitals, Dartmouth College working paper.

Li, Kai, Xing Liu, Feng Mai, and Tengfei Zhang, 2021. The role of corporate culture in bad times: Evidence from the COVID-19 pandemic. *Journal of Financial and Quantitative Analysis* 56, 2545–2583.

Li, Xiaoyang, and Yue M. Zhou, 2017. Offshoring pollution while offshoring production? *Strategic Management Journal* 38, 2310–2329.

Matsa, David A., and Amalia R. Miller, 2013. A female style in corporate leadership? Evidence from quotas, *American Economic Journal: Applied Economics* 5, 136–169.

MacKinnon, James G., Morten Ørregaard Nielsen, and Matthew D. Webb, 2022. Cluster-robust inference: A guide to empirical practice, *Journal of Econometrics* in press.

Meyerinck, Felix von, Alexandra Niessen-Ruenzi, Markus Schmid, and Steven Davidoff Solomon, 2021. As California goes, so goes the nation? Board gender quotas and shareholders' distaste of government interventions, University of St. Gallen working paper.

Pan, Yihui, Stephan Siegel, and Tracy Wang, 2017. Corporate risk culture, *Journal of Financial and Quantitative Analysis* 52, 2327–2367.

Pan, Yihui, Stephan Siegel and Tracy Wang, 2020. The cultural origin of CEOs' attitudes towards uncertainty: Evidence from corporate acquisitions, *Review of Financial Studies* 33, 2977–3030.

PwC, 2019. PwC's Annual Corporate Directors' Survey, available at: http://www.circulodedirectores.org/wp-content/uploads/2019/12/pwc-2019-annual-corporate-directors-survey-full-report-v2.pdf (assessed on October 3, 2022)

Refinitiv, 2022. Environmental, social, and governance scores from Refinitiv, available at: https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf (assessed on October 3, 2022)

Rose, Clayton S., and William T. Bielby, 2011. Race at the top: How companies shape the inclusion of African Americans on their boards in response to institutional pressures, *Social Science Research* 40, 841–859.

Ryan, Michelle K., and S. Alexander Haslam, 2007. The glass cliff: Exploring the dynamics surrounding the appointment of women to precarious leadership positions, *Academy of Management Review* 32, 549–572.

Tate, Geoffrey, and Liu Yang, 2015. Female leadership and gender equity: Evidence from plant closure, *Journal of Financial Economics* 117, 77–97.

Schwartz, Shalom H., and Tammy Rubel, 2005. Sex differences in value priorities: Cross-cultural and multimethod studies, *Journal of Personality and Social Psychology* 89, 1010–1028.

Silverman, Irwin W., 2003. Gender differences in delay of gratification: A meta-analysis, *Sex Roles* 49, 451–463.

Starks, Laura T., Parth Venkat, and Qifei Zhu, 2020. Corporate ESG profiles and investor horizons, University of Texas at Austin working paper.

Sugarman, David B., and Murray A. Straus, 1988. Indicators of gender equality for American states and regions, *Social Indicators Research* 20, 229–270.

Zhou, Xianming, 2001. Understanding the determinants of managerial ownership and the link between ownership and performance: Comment, *Journal of Financial Economics* 62, 559–571.

Figure 1
The share of female directors over time

This figure plots the temporal trend in the share of female directors over time. The x-axis shows the fiscal year. The y-axis is the average *Female director ratio* across sample firms in a fiscal year. Our sample comprises 21,728 firm-year observations representing 3,198 firms over the period 2001–2020.

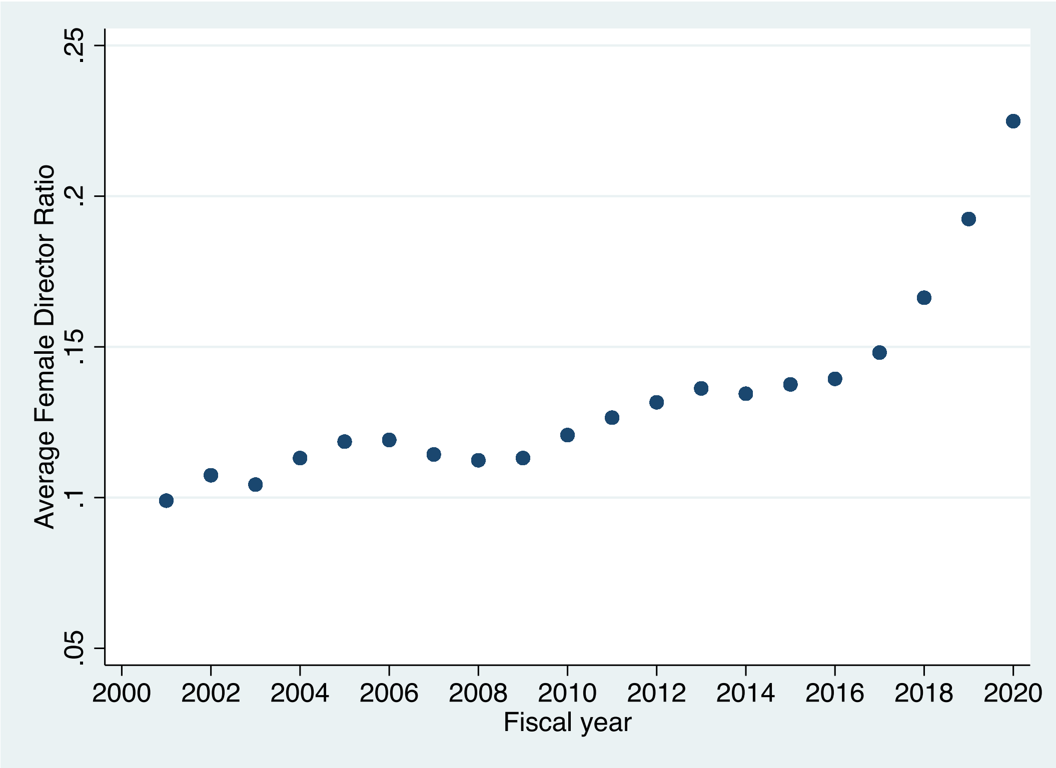


Table 1
Sample formation

This table lists the steps taken and filters applied to form the samples used in our analyses. Panel A reports the steps and filters applied to form our main sample of 21,728 firm-year observations for a sample of 3,198 firms over the period 2002–2021. Panel B reports the steps and filters applied to form our facility-level sample of 48,595 facility-year observations for a sample of 4,699 facilities associated with 627 firms over the period 2002–2021.

Panel A: Firm sample formation

	#firm-year obs.	#firm-year obs. removed	#unique firms
WRDS Refinitiv ESG over the period 2002–2021	24,525		3,588
Remove observations with missing data from BoardEx	23,799	726	3,504
Remove observations with missing data form Compustat	23,135	664	3,365
Remove observations with missing data form WRDS Thomson 13F	23,070	65	3,360
Remove observations without Augmented 10-X Header Data	22,848	222	3,258
Remove observations due to fixed effects	21,728	1,120	3,198
Final sample	21,728		3,198

Panel B: Facility sample formation

	#facility-year obs.	#facility-year obs. removed	#unique facilities
TRI facility-year observations matched to GVKEY over the period 1991–2021	166,453		14,008
Remove observations not covered by NETS	109,679	52,135	9,739
Remove observations not in our baseline firm sample	90,955	18,724	8,605
Remove observations with missing data used in regression analysis	50,061	40,984	5,286
Remove observations due to fixed effects	48,595	1,466	4,699
Final sample	48,595		4,699

Table 2
Summary statistics

This table provides the summary statistics for our firm and facility samples. Panel A presents the summary statistics for the firm-level variables of 21,728 firm-year observations for a sample of 3,198 firms over the period 2002–2021. Panel B presents the correlation matrix for variables in the firm sample. Panel C presents the summary statistics for the facility-level variables of 48,595 facility-year observations for a sample of 4,699 facilities associated with 627 firms over the period 2002–2021. Definitions of the variables are provided in the Appendix.

Panel A: Summary statistics for the firm sample

	Mean (1)	SD (2)	P5 (3)	Median (4)	P95 (5)
E score	0.211	0.253	0.000	0.097	0.737
Emissions reduction score	0.241	0.302	0.000	0.082	0.875
Innovation score	0.148	0.258	0.000	0.000	0.788
Resource use score	0.245	0.312	0.000	0.046	0.891
Female director ratio	0.150	0.107	0.000	0.143	0.333
Board size	10.977	3.721	6.000	10.000	17.000
Board independence	0.761	0.125	0.545	0.778	0.909
Board busyness	0.146	0.141	0.000	0.125	0.412
Female CEO	0.038	0.192	0.000	0.000	0.000
Top5 institutions	0.313	0.120	0.123	0.310	0.505
M/B	3.428	5.691	0.491	2.201	11.895
Firm size	8.186	1.883	5.015	8.185	11.287
ROA	0.002	0.173	-0.289	0.027	0.155
Leverage	0.274	0.221	0.000	0.244	0.696
Cash holdings	0.161	0.203	0.005	0.077	0.638
SG&A	0.276	0.659	0.000	0.160	0.689

Panel B: Correlation matrix of the firm sample

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	E score	1.000												
2	Female director ratio	0.250***	1.000											
3	Board size	0.424***	0.104***	1.000										
4	Board independence	-0.215***	0.124***	-0.414***	1.000									
5	Board busyness	0.209***	0.075***	0.161***	-0.019***	1.000								
6	Female CEO	0.032***	0.252***	-0.022***	0.044***	0.012*	1.000							
7	Top5 institutions	-0.039***	0.074***	-0.205***	0.189***	-0.007	0.019***	1.000						
8	M/B	0.009	0.036***	-0.019***	-0.049***	0.021***	0.020***	0.014**	1.000					
9	Firm size	0.499***	0.143***	0.703***	-0.319***	0.142***	-0.026***	-0.128***	-0.128***	1.000				
10	ROA	0.184***	0.043***	0.214***	-0.160***	-0.010	-0.033***	-0.012*	-0.037***	0.350***	1.000			
11	Leverage	0.101***	0.051***	-0.033***	0.015**	0.031***	0.011	0.123***	-0.064***	0.110***	-0.043***	1.000		
12	Cash holdings	-0.178***	-0.033***	-0.245***	0.029***	0.062***	0.033***	0.062***	0.226***	-0.452***	-0.401***	-0.252***	1.000	
13	SG&A	-0.120***	-0.019***	-0.119***	0.056***	-0.013*	0.021***	-0.008	0.095***	-0.257***	-0.354***	-0.087***	0.296***	1.000

Panel C: Summary statistics for the facility sample

	Mean	SD	P5	Median	P95
	(1)	(2)	(3)	(4)	(5)
#Source reduction practices by chemical	0.348	1.283	0.000	0.000	2.000
#Source reduction practices by facility	0.190	0.610	0.000	0.000	1.000
Total production waste (in millions of pounds)	1.269	3.880	0.000	0.045	8.058
ln(#Source reduction practices by chemical + 1)	0.143	0.433	0.000	0.000	1.099
ln(#Source reduction practices by facility + 1)	0.107	0.311	0.000	0.000	0.693
ln(Total production waste + 1)	0.370	0.710	0.000	0.044	2.204
Female director ratio	0.136	0.086	0.000	0.133	0.286
Board size	13.048	3.275	7.000	13.000	18.000
Board independence	0.713	0.112	0.545	0.688	0.900
Board busyness	0.194	0.142	0.000	0.182	0.444
Female CEO	0.029	0.168	0.000	0.000	0.000
Top5 institutions	0.277	0.100	0.105	0.278	0.433
M/B	2.984	4.308	0.865	2.266	7.840
Firm size	9.124	1.923	6.200	9.005	12.764
ROA	0.047	0.066	-0.045	0.047	0.136
Leverage	0.284	0.146	0.060	0.270	0.550
Cash holdings	0.087	0.078	0.006	0.067	0.234
SG&A	0.126	0.105	0.000	0.109	0.322
Sales (in millions of dollars)	149.737	298.938	2.247	53.304	648.230
#Employees	429.579	707.6062	9	200	1618
ln(Sales +1)	17.638	1.664	14.625	17.792	20.290
ln(#Employees +1)	5.114	1.530	2.303	5.303	7.390
Credit score	73.736	5.526	64.000	75.000	80.000

Table 3
Female directors and corporate environmental performance

This table examines the relation between the share of female directors on a board and corporate environmental performance. The sample consists of 21,728 firm-year observations over the period 2002–2021. We use four different environmental scores as the dependent variables: *E score*, *Emissions reduction score*, *Innovation score*, and *Resource use score*. Our variable of interest is *Female director ratio*, the number of female directors scaled by board size. We include (three-digit SIC) industry times year fixed effects. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

	E score (1)	Emissions reduction score (2)	Innovation score (3)	Resource use score (4)
Female director ratio	0.222***	0.274***	0.109***	0.285***
	(0.027)	(0.033)	(0.031)	(0.034)
Board size	0.015***	0.018***	0.008***	0.018***
	(0.001)	(0.002)	(0.002)	(0.002)
Board independence	-0.185***	-0.230***	-0.099***	-0.227***
	(0.030)	(0.037)	(0.034)	(0.037)
Board busyness	0.105***	0.128***	0.043*	0.143***
	(0.021)	(0.025)	(0.025)	(0.025)
Female CEO	-0.001	-0.006	0.003	0.000
	(0.014)	(0.016)	(0.018)	(0.016)
Top5 institutions	-0.091***	-0.119***	-0.069***	-0.085***
	(0.023)	(0.027)	(0.026)	(0.027)
M/B	0.001**	0.001**	0.000	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Firm size	0.068***	0.076***	0.046***	0.081***
	(0.003)	(0.004)	(0.004)	(0.004)
ROA	-0.033**	-0.024	-0.040***	-0.036**
	(0.014)	(0.017)	(0.015)	(0.017)
Leverage	-0.056***	-0.059***	-0.047***	-0.062***
	(0.015)	(0.019)	(0.017)	(0.019)
Cash holdings	0.025	0.032	0.054**	-0.011
	(0.020)	(0.024)	(0.023)	(0.023)
SG&A	0.001	0.003	-0.001	0.001
	(0.002)	(0.003)	(0.002)	(0.002)
Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	21,728	21,728	21,728	21,728
Adj-R^2	0.562	0.522	0.370	0.516

Table 4
Female directors and corporate environmental performance: firm fixed effects

This table examines within-firm temporal variations in the share of female directors on a board in relation to within-firm temporal variations in corporate environmental performance by including firm fixed effects. The sample consists of 21,485 firm-year observations over the period 2002–2021. We use four different environmental scores as the dependent variables: *E score*, *Emissions reduction score*, *Innovation score*, and *Resource use score*. Our variable of interest is *Female director ratio*, the number of female directors scaled by board size. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

	E score	Emissions reduction score	Innovation score	Resource use score
	(1)	(2)	(3)	(4)
Female director ratio	0.074***	0.080***	0.027	0.114***
	(0.023)	(0.029)	(0.031)	(0.032)
Board size	0.003***	0.004**	0.002	0.004**
	(0.001)	(0.002)	(0.001)	(0.002)
Board independence	-0.117***	-0.105***	-0.109***	-0.138***
	(0.026)	(0.033)	(0.033)	(0.036)
Board busyness	-0.008	-0.001	-0.033	0.008
	(0.016)	(0.020)	(0.023)	(0.022)
Female CEO	-0.005	-0.023	0.001	0.007
	(0.014)	(0.022)	(0.017)	(0.017)
Top5 institutions	-0.041**	-0.057**	-0.015	-0.050**
	(0.018)	(0.023)	(0.024)	(0.022)
M/B	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Firm size	0.024***	0.041***	-0.003	0.033***
	(0.005)	(0.007)	(0.006)	(0.006)
ROA	-0.017*	-0.018	-0.002	-0.030**
	(0.010)	(0.013)	(0.011)	(0.013)
Leverage	-0.023*	-0.025	-0.032*	-0.012
	(0.013)	(0.018)	(0.017)	(0.019)
Cash holdings	0.026	0.044**	-0.007	0.040*
	(0.018)	(0.022)	(0.022)	(0.023)
SG&A	-0.002	-0.003	-0.002*	-0.001
	(0.002)	(0.003)	(0.001)	(0.003)
Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	21,485	21,485	21,485	21,485
Adj-R^2	0.843	0.807	0.734	0.805

Table 5
Female directors and corporate environmental performance: 2SLS

This table examines the relation between the share of female directors on a board and corporate environmental performance using 2SLS regressions. The sample consists of 21,509 firm-year observations over the period 2002–2021. Column (1) reports the first-stage regression results, where *Gender Equality Index* and *Affirmative Action* are used as the instrumental variables. Columns (2) to (5) tabulate the second-stage regression results with the four environmental scores as the dependent variables: *E score*, *Emissions reduction score*, *Innovation score*, and *Resource use score*. Our variable of interest is *Female director ratio*, the number of female directors scaled by board size. We include the same set of firm-level controls as in Table 3. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

	Female director ratio	E score	Emissions reduction score	Innovation score	Resource use score
	1st stage	2nd stage			
	(1)	(2)	(3)	(4)	(5)
Gender Equality Index	0.118***				
	(0.034)				
Affirmative Action	0.068***				
	(0.009)				
Female director ratio		1.023***	1.124***	0.876***	1.068***
		(0.253)	(0.297)	(0.285)	(0.311)
Firm-level controls	Yes	Yes	Yes	Yes	Yes
Industry × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
First-stage F-statistic	38.17***				
Overidentification test (Hansen's J statistic)		0.617	0.635	0.714	0.616
Obs.	21,509	21,509	21,509	21,509	21,509
Adj-R^2	0.291	0.264	0.254	-0.038	0.276

Table 6
Female directors and corporate environmental performance: California's SB 826

This table examines changes in both the share of female directors on a board and corporate environmental performance between the treated and control firms around the enactment of California's SB 826, which imposes a female director quota on firms headquartered in California since 2018. The treated firms are public firms without a female director in 2018 and headquartered (and stayed) in California. We find the closest control firm for each treated firm by matching on (three-digit SIC) industry, firm size, and *E score*. Panel A presents the sanity check on the impact of the California law change on the share of female directors in the treated firms compared to that in the control firms. In column (1), we regress *Female director ratio* on *Treated* × *Post*, an interaction term between the indicator variable *Treated* and the indicator variable, *Post*, for the post-event window (2019 to 2021). Column (2) employs a dynamic DID specification by interacting *Treated* with the year indicators for each year within the event window examined. Panel B presents the DID analysis with the four environmental scores as the dependent variables. We include the same set of firm-level controls as in Table 3. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the state level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Panel A: CA law change and the share of female directors

	Female director ratio	
	(1)	(2)
Treated × Post	0.063***	
	(0.010)	
Treated × Year 2015		-0.004
		(0.012)
Treated × Year 2016		-0.002
		(0.012)
Treated × Year 2017		-0.010
		(0.013)
Treated × Year 2019		0.040**
		(0.014)
Treated × Year 2020		0.064***
		(0.015)
Treated × Year 2021		0.080***
		(0.023)
Firm-level controls	Yes	Yes
Industry × Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Intercept	Yes	Yes
Obs.	543	543
Adj-R^2	0.765	0.765

Panel B: CA law change and corporate environmental performance

	E score		Emissions reduction score		Innovation score	Resource use score
	(1)	(2)	(3)	(4)	(5)	(6)
Treated × Post	0.030***		0.057***		0.016	0.016
	(0.009)		(0.015)		(0.011)	(0.021)
Treated × Year 2015		-0.040		-0.039		
		(0.028)		(0.044)		
Treated × Year 2016		-0.014		-0.010		
		(0.024)		(0.034)		
Treated × Year 2017		-0.005		-0.011		
		(0.006)		(0.008)		
Treated × Year 2019		0.021***		0.045***		
		(0.006)		(0.011)		
Treated × Year 2020		0.028**		0.059**		
		(0.012)		(0.023)		

Treated × Year 2021		0.026*		0.050*		
		(0.014)		(0.029)		
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	432	432	432	432	432	432
Adj-R^2	0.649	0.644	0.608	0.603	0.554	0.652

Table 7
Female directors and facility-level environmental performance

This table examines the relation between the share of female directors on a board and facility-level environmental performance. The sample consists of 48,595 facility-year observations for a sample of 4,699 facilities associated with 627 firms over the period 2002–2021. Panels A and B present the results where the dependent variables are facility-level pollution prevention measures: *ln(#Source reduction practices by chemical + 1)* and *ln(#Source reduction practices by facility + 1)*. Panel C presents the results where the dependent variable is facility-level total quantity of production-related waste, *ln(Total production waste + 1)*. We include three facility-level controls, the same set of firm-level controls as in Table 3, as well as facility fixed effects, firm-level (three-digit SIC) industry times year fixed effects, facility-level (three-digit SIC) industry times year fixed effects, firm headquarters states times year fixed effects, and facility states times year fixed effects. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Panel A: Female directors and facility-level pollution source reduction practices by chemical

	(1)	(2)	(3)	(4)
Female director ratio	0.203**	0.216**	0.205**	0.217**
	(0.087)	(0.088)	(0.087)	(0.088)
ln(Sales)			0.004	0.005
			(0.019)	(0.019)
ln(#Employees)			0.007	0.006
			(0.020)	(0.020)
Credit score			0.001	0.001
			(0.001)	(0.001)
Firm-level controls	Yes	Yes	Yes	Yes
Facility Fixed Effects	Yes	Yes	Yes	Yes
Firm Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Firm HQ State × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility State × Year Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	48,595	48,595	48,595	48,595
Adj-R^2	0.498	0.499	0.499	0.499

Panel B: Female directors and facility-level pollution source reduction practices by facility

	(1)	(2)	(3)	(4)
Female director ratio	0.126**	0.131**	0.127**	0.132**
	(0.061)	(0.061)	(0.061)	(0.061)
ln(Sales)			-0.004	-0.004
			(0.014)	(0.013)
ln(#Employees)			0.010	0.009
			(0.015)	(0.015)
Credit score			0.001*	0.001*
			(0.000)	(0.000)
Firm-level controls	Yes	Yes	Yes	Yes
Facility Fixed Effects	Yes	Yes	Yes	Yes
Firm Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Firm HQ State × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility State × Year Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	48,595	48,595	48,595	48,595
Adj-R^2	0.469	0.469	0.469	0.469

Panel C: Female directors and facility-level total production waste

	(1)	(2)	(3)	(4)
Female director ratio	-0.169***	-0.168***	-0.167***	-0.167***
	(0.062)	(0.061)	(0.062)	(0.061)
ln(Sales)			0.006	0.008
			(0.013)	(0.013)
ln(#Employees)			0.003	0.001
			(0.014)	(0.014)
Credit score			0.000	0.000
			(0.000)	(0.000)
Firm-level controls	Yes	Yes	Yes	Yes
Facility Fixed Effects	Yes	Yes	Yes	Yes
Firm Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Firm HQ State × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility State × Year Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	48,595	48,595	48,595	48,595
Adj-R^2	0.928	0.928	0.928	0.928

Table 8
Director qualifications, committee roles, and governance roles

This table examines whether female directors are different from their male counterparts in terms of qualifications, committee roles, and governance roles. Panel A presents the regression results comparing female and male directors in age, board tenure, and educational background. Panel B presents the regression results comparing female and male directors in skill sets and industry and finance experience. Panel C presents the regression results comparing female and male directors in board leadership and committee affiliations, controlling for other director characteristics. Panel D presents the regression analysis examining the relation between the share of female directors and a firm having ESG-linked compensation policy for executives, ESG (executive) committee, and ESG reporting controlling for firm characteristics. Definitions of the variables are provided in the Appendix. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Panel A: Director age, tenure, and educational background

	Age	Tenure	Field_ business	Field_ law	Field_ medicine	Field_ STEM	# Fields	Highest degree
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Female	-3.359***	-2.320***	-0.035***	0.007	0.002	-0.057***	-0.083***	0.100***
	(0.115)	(0.102)	(0.009)	(0.006)	(0.003)	(0.009)	(0.013)	(0.013)
Firm × Year Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	202,612	206,237	193,029	193,029	193,029	193,029	193,029	193,031
Adj-R^2	0.136	0.227	0.033	0.027	0.102	0.048	0.034	0.054

Panel B: Director skill sets

	Skill_ academic	Skill_ community	Skill_ environment	Skill_ government	Skill_ risk mgt	Skill_ tech	# Skills	Industry experience	Finance experience
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Female	0.050***	0.061***	0.019***	0.056***	0.034***	0.010*	0.230***	-0.169***	-0.029***
	(0.007)	(0.005)	(0.003)	(0.007)	(0.004)	(0.006)	(0.016)	(0.005)	(0.007)
Firm × Year Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	206,237	206,237	206,237	206,237	206,237	206,237	206,237	194,447	194,404
Adj-R^2	0.033	0.015	0.015	0.063	0.009	0.084	0.062	0.154	0.031

Panel C: Board leadership and committee affiliations

	Chairman of the Board	Lead director	Audit committee	Compensation committee	ESG committee	Nomination committee
	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.086***	-0.018***	0.090***	0.044***	0.015***	0.066***
	(0.002)	(0.002)	(0.008)	(0.007)	(0.002)	(0.006)
Age	-0.003***	0.002***	0.010***	0.008***	0.000***	0.006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Tenure	0.012***	0.003***	-0.011***	-0.002***	-0.000**	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Field_business	-0.009**	0.012***	0.101***	0.004	-0.006***	-0.004
	(0.004)	(0.003)	(0.007)	(0.006)	(0.002)	(0.005)
Field_law	-0.004	0.014***	-0.012	-0.000	-0.001	0.064***
	(0.007)	(0.005)	(0.013)	(0.011)	(0.004)	(0.010)
Field_medicine	-0.031***	-0.025***	-0.131***	-0.058***	-0.003	0.034**
	(0.009)	(0.006)	(0.019)	(0.021)	(0.005)	(0.017)
Field_STEM	0.014***	0.003	0.003	-0.006	-0.002	-0.008
	(0.004)	(0.003)	(0.007)	(0.006)	(0.002)	(0.005)
Highest degree	-0.002	0.001	-0.029***	0.010**	0.004**	0.008*
	(0.003)	(0.002)	(0.006)	(0.005)	(0.002)	(0.004)
Skill_academic	-0.039***	0.004	0.037***	0.004	0.004	0.042***
	(0.005)	(0.004)	(0.010)	(0.009)	(0.003)	(0.008)
Skill_community	-0.022***	0.001	-0.011	0.003	0.008**	0.012
	(0.006)	(0.005)	(0.013)	(0.011)	(0.004)	(0.010)
Skill_environment	0.009	-0.014*	-0.023	-0.000	0.020***	0.022
	(0.012)	(0.007)	(0.022)	(0.018)	(0.008)	(0.016)
Skill_government	0.006	0.002	-0.054***	-0.004	0.006**	0.036***
	(0.005)	(0.004)	(0.009)	(0.008)	(0.002)	(0.007)
Skill_risk mgt	-0.023***	-0.010**	0.054***	-0.043***	-0.003	-0.024**
	(0.007)	(0.005)	(0.014)	(0.013)	(0.004)	(0.011)
Skill_tech	0.005	-0.007**	-0.072***	-0.005	0.009***	-0.001
	(0.005)	(0.003)	(0.009)	(0.008)	(0.003)	(0.007)
Firm Fixed Effects	Yes	Yes				
Industry × Year Fixed Effects	Yes	Yes				
Firm × Year Fixed Effects			Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	192,844	192,844	192,844	192,844	192,844	192,844
Adj-R^2	0.061	0.048	0.002	0.091	0.427	0.235

Panel D: Female directors and executive compensation, ESG (executive) committee, and ESG reporting

	Compensation policy including ESG metric	ESG (executive) committee	ESG reporting
	(1)	(2)	(3)
Female director ratio	0.123**	0.138**	0.155***
	(0.058)	(0.061)	(0.060)
Board size	-0.000	0.006**	0.008***
	(0.003)	(0.003)	(0.003)
Board independence	0.029	-0.194***	-0.186***
	(0.055)	(0.064)	(0.059)
Board busyness	-0.028	-0.010	-0.112***
	(0.039)	(0.042)	(0.041)
Female CEO	0.041	0.001	-0.003
	(0.041)	(0.036)	(0.037)
Top5 institutions	-0.057	-0.050	-0.067
	(0.041)	(0.041)	(0.044)
M/B	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)
Firm size	0.007	0.041***	0.053***
	(0.012)	(0.013)	(0.012)
ROA	0.017	-0.016	-0.029
	(0.024)	(0.022)	(0.023)
Leverage	0.014	-0.079**	-0.054*
	(0.037)	(0.032)	(0.032)
Cash holdings	0.000	0.037	0.096**
	(0.046)	(0.044)	(0.042)
SG&A	-0.001	0.003	-0.002
	(0.005)	(0.004)	(0.004)
Industry × Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Intercept	Yes	Yes	Yes
Obs.	19,551	19,551	19,551
$Adj\text{-}R^2$	0.706	0.673	0.640

Internet Appendix for "The Eco Gender Gap in Boardrooms"

Table IA1
Female directors and corporate environmental performance: robustness checks

This table examines the relation between the share of female directors on a board and corporate environmental performance controlling for additional executive and board characteristics. Panel A controls for the share of female top executives. Panel B controls for the average age of male independent directors on a board and the average age of top executives. We use four different environmental scores as the dependent variables: *E score*, *Emissions reduction score*, *Innovation score*, and *Resource use score*. Our variable of interest is *Female director ratio*, the number of female directors scaled by board size. We include (three-digit SIC) industry times year fixed effects to control for industry-specific time trends in both the share of female directors and corporate environmental performance. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Panel A: Controlling for the share of female top executives

	E score	Emissions reduction score	Innovation score	Resource use score
	(1)	(2)	(3)	(4)
Female director ratio	0.241***	0.271***	0.163***	0.288***
	(0.040)	(0.048)	(0.045)	(0.049)
Board size	0.012***	0.015***	0.006***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)
Board independence	-0.162***	-0.191***	-0.100**	-0.195***
	(0.038)	(0.048)	(0.043)	(0.049)
Board busyness	0.132***	0.170***	0.048	0.179***
	(0.028)	(0.035)	(0.033)	(0.035)
Female top executive ratio	0.007	0.017	-0.037	0.041
	(0.026)	(0.031)	(0.031)	(0.032)
Top5 institutions	-0.062*	-0.091**	-0.042	-0.053
	(0.034)	(0.040)	(0.039)	(0.041)
M/B	0.001*	0.001*	0.000	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Firm size	0.086***	0.098***	0.059***	0.101***
	(0.004)	(0.005)	(0.005)	(0.005)
ROA	0.058**	0.096***	0.014	0.063*
	(0.027)	(0.033)	(0.030)	(0.035)
Leverage	-0.062***	-0.069**	-0.059**	-0.058**
	(0.022)	(0.028)	(0.027)	(0.029)
Cash holdings	0.097***	0.136***	0.102***	0.054
	(0.031)	(0.038)	(0.038)	(0.038)
SG&A	-0.013	-0.007	-0.023	-0.010
	(0.016)	(0.019)	(0.019)	(0.021)
Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	15,411	15,411	15,411	15,411
Adj-R^2	0.564	0.524	0.369	0.510

Panel B: Controlling for the average age of male independent directors and the average age of top executives

	E score	Emissions reduction score	Innovation score	Resource use score
	(1)	(2)	(3)	(4)
Female director ratio	0.247***	0.280***	0.152***	0.310***
	(0.039)	(0.047)	(0.045)	(0.048)
Board size	0.012***	0.015***	0.007***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)
Board independence	-0.165***	-0.195***	-0.102**	-0.198***
	(0.039)	(0.049)	(0.044)	(0.050)
Board busyness	0.131***	0.168***	0.049	0.176***
	(0.028)	(0.035)	(0.033)	(0.035)
Average age of male independent directors	-0.002**	-0.002**	-0.001	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Average age of top executives	0.000	0.000	0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Top5 institutions	-0.068**	-0.098**	-0.048	-0.058
	(0.034)	(0.040)	(0.040)	(0.042)
M/B	0.001	0.001	0.000	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Firm size	0.086***	0.098***	0.059***	0.101***
	(0.004)	(0.005)	(0.005)	(0.005)
ROA	0.059**	0.099***	0.016	0.062*
	(0.027)	(0.033)	(0.030)	(0.035)
Leverage	-0.062***	-0.069**	-0.056**	-0.061**
	(0.023)	(0.028)	(0.028)	(0.029)
Cash holdings	0.095***	0.133***	0.099***	0.052
	(0.031)	(0.038)	(0.038)	(0.038)
SG&A	-0.016	-0.010	-0.024	-0.014
	(0.016)	(0.020)	(0.019)	(0.021)
Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	15,269	15,269	15,269	15,269
Adj-R^2	0.566	0.524	0.369	0.511

Table IA2
Female directors and corporate environmental performance: 2SLS with additional controls

This table examines the relation between the share of female directors on a board and corporate environmental performance using 2SLS regressions with additional controls: the average age of male independent directors on a board and the average age of top executives. Column (1) reports the first-stage regression results, where *Gender Equality Index* and *Affirmative Action* are used as the instrumental variables. Columns (2) to (5) tabulate the second-stage regression results with the four environmental scores as the dependent variables: *E score*, *Emissions reduction score*, *Innovation score*, and *Resource use score*. Our variable of interest is *Female director ratio*, the number of female directors scaled by board size. We include (three-digit SIC) industry times year fixed effects to control for industry-specific time trends in both the share of female directors and corporate environmental performance. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

	Female director ratio	E score	Emissions reduction score	Innovation score	Resource use score
	1st stage	2nd stage			
	(1)	(2)	(3)	(4)	(5)
Gender Equality Index	0.099**				
	(0.043)				
Affirmative Action	0.110***				
	(0.013)				
Female director ratio		1.148***	1.251***	1.029***	1.164***
		(0.270)	(0.322)	(0.309)	(0.331)
Board size	0.003***	0.010***	0.012***	0.004**	0.012***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Board independence	0.093***	-0.245***	-0.281***	-0.180***	-0.275***
	(0.016)	(0.046)	(0.056)	(0.052)	(0.059)
Board busyness	0.049***	0.084***	0.117***	0.003	0.132***
	(0.012)	(0.032)	(0.039)	(0.036)	(0.040)
Female CEO	0.110***	-0.100***	-0.115**	-0.096**	-0.088*
	(0.010)	(0.038)	(0.046)	(0.044)	(0.046)
Average age of male independent directors	0.003***	-0.002*	-0.002*	-0.001	-0.002
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Average age of top executives	-0.000	0.001	0.001	0.001	0.000
	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)
Top5 institutions	0.022	-0.090**	-0.121***	-0.069	-0.078*
	(0.018)	(0.037)	(0.044)	(0.043)	(0.044)
M/B	-0.000	0.001	0.001	0.000	0.001*
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Firm size	0.010***	0.076***	0.087***	0.049***	0.092***
	(0.002)	(0.005)	(0.006)	(0.006)	(0.006)
ROA	0.043***	0.023	0.059	-0.019	0.027
	(0.013)	(0.031)	(0.038)	(0.034)	(0.040)
Leverage	-0.005	-0.061**	-0.067**	-0.055*	-0.059*
	(0.011)	(0.025)	(0.030)	(0.029)	(0.031)
Cash holdings	0.007	0.085**	0.122***	0.089**	0.043
	(0.014)	(0.034)	(0.040)	(0.040)	(0.041)
SG&A	0.005	-0.020	-0.014	-0.028	-0.017

	(0.008)	(0.018)	(0.020)	(0.022)	(0.021)
Industry × Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
Obs.	15,265	15,265	15,265	15,265	15,265
Adj-R^2	0.345	0.254	0.238	-0.064	0.254

Table IA3
Additional firm-level analysis related to California's SB 826

This table conducts additional firm-level analysis related to California's SB 826. Panel A compares the share of female directors on a board and corporate environmental performance between the treated and control firms before and after the enactment of California's SB 826. The treated firms are public firms without a female director in 2018 and headquartered (and stayed) in California. We find the closest control firm for each treated firm by matching on (three-digit SIC) industry, firm size, and *E score*. Pre-event represents the pre-event window (2015 to 2017). Post-event represents the post-event window (2019 to 2021). Panel B repeats the DID analysis in Table 6 using 2016 as the pseudo event year. Panel C repeats the DID analysis in Table 6 using the same treated firms while the control firms are chosen from those headquartered in California with at least two female directors in 2018, in the same (three-digit SIC) industry, and closest in firm size and *E score* to the treated firms. Standard errors (in parentheses) are clustered at the state level in Panel B and at the treatment level in Panel C. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Panel A: Comparing treated and control firms in female director share and E score

	Female director ratio			E score		
	Treated	Control	Treated – Control	Treated	Control	Treated – Control
	(1)	(2)	(3)	(4)	(5)	(6)
Pre-event	0.019	0.017	0.003	0.016	0.014	0.001
Post-event	0.209	0.130	0.078***	0.052	0.039	0.013*
Post – Pre			0.075***			0.012

Panel B: DID analysis using 2016 as the pseudo event year

	Female director ratio	E score
	(1)	(2)
Treated × Post	0.008	0.007
	(0.006)	(0.015)
Firm-level controls	Yes	Yes
Industry × Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Intercept	Yes	Yes
Obs.	487	285
Adj-R^2	0.620	0.671

Panel C: DID analysis using control firms headquartered in California with at least two female directors in 2018

	Female director ratio	E score
	(1)	(2)
Treated × Post	0.119**	0.018**
	(0.004)	(0.001)
Firm-level controls	Yes	Yes
Industry × Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Intercept	Yes	Yes
Obs.	359	300
Adj-R^2	0.806	0.841

Table IA4
Female directors and facility-level environmental performance: Poisson regressions

This table examines the relation between the share of female directors on a board and facility-level environmental performance using Poisson regressions. The dependent variables are facility-level pollution prevention measures: *#Source reduction practices by chemical* and *#Source reduction practices by facility*. The sample consists of 48,595 facility-year observations for a sample of 4,699 facilities associated with 627 firms over the period 2002–2021. The sample size drops to 15,248 facility-year observations when running Poisson regressions. We include the same set of firm-level controls as in Table 3. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Panel A: Female directors and facility-level pollution source reduction practices by chemical

	(1)	(2)	(3)	(4)
Female director ratio	2.054**	2.049**	2.030**	2.022**
	(0.829)	(0.810)	(0.830)	(0.812)
ln(Sales)			0.052	0.051
			(0.174)	(0.176)
ln(#Employees)			-0.054	-0.046
			(0.199)	(0.202)
Credit score			0.007	0.008*
			(0.005)	(0.005)
Firm-level controls	Yes	Yes	Yes	Yes
Facility Fixed Effects	Yes	Yes	Yes	Yes
Firm Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Firm HQ State × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility State × Year Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	15,248	15,248	15,248	15,248

Panel B: Female directors and facility-level pollution source reduction practices by facility

	(1)	(2)	(3)	(4)
Female director ratio	2.036***	2.015***	2.023***	2.002***
	(0.765)	(0.753)	(0.768)	(0.755)
ln(Sales)			0.021	0.004
			(0.142)	(0.141)
ln(#Employees)			0.018	0.038
			(0.159)	(0.160)
Credit score			0.007	0.007
			(0.005)	(0.005)
Firm-level controls	Yes	Yes	Yes	Yes
Facility Fixed Effects	Yes	Yes	Yes	Yes
Firm Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Firm HQ State × Year Fixed Effects	Yes	Yes	Yes	Yes
Facility State × Year Fixed Effects	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	15,248	15,248	15,248	15,248

Table IA5
Facility-level analysis related to California's SB 826

This table conducts facility-level analysis related to California's SB 826. Panel A compares total production waste between the treated and control firms before and after the enactment of California's SB 826. The treated firms are public firms without a female director in 2018 and headquartered (and stayed) in California. We find the closest control firm for each treated firm by matching on (three-digit SIC) industry, firm size, and *E score*. Pre-event represents the pre-event window (2015 to 2017). Post-event represents the post-event window (2019 to 2021). Panel B repeats the DID analysis with facility fixed effects (Column 2). Standard errors (in parentheses) are clustered at the state level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

Panel A: Comparing treated and control firms in total production waste

	ln(Total production waste + 1)		
	Treated	Control	Treated − Control
	(1)	(2)	(3)
Pre-event	0.073	0.006	0.067***
Post-event	0.057	0.008	0.049*
Post − Pre			-0.018**

Panel B: DID analysis with controls

	(1)	(2)
	ln(Total production waste + 1)	
Treated × Post	-0.018**	-0.010**
	(0.005)	(0.002)
Treated	0.067***	
	(0.007)	
Post	0.002	-0.002
	(0.005)	(0.002)
Facility Fixed Effects		Yes
Intercept	Yes	Yes
Obs.	50	49
Adj-R^2	0.201	0.965

Table IA6
Additional summary statistics

This table provides additional summary statistics for variables used in Section 6. Panels A, B, and C report the two-sample t-test comparing female and male directors in various characteristics, skills, experience, board leadership and committee affiliations. The sample comprises 206,237 director-year observations over the period 2002–2021 from BoardEx/Refinitiv. Panel D provides the summary statistics for directors' board leadership roles and committee affiliations. Panel E provides the summary statistics for firms' key board committees based on the same sample as that in Panel D, resulting in 21,548 firm-year observations. Panel F provides the summary statistics for firms' ESG-linked compensation policy, ESG (executive) committees, and ESG reporting based on a sample of 19,879 firm-year observations over the period 2002–2021 from Refinitiv. Definitions of the variables are provided in the Appendix.

Panel A: Director age, tenure, and educational background

	Group mean for directors		Diff. in mean t-test
	Female	Male	
	(1)	(2)	(3)
Age	59.640	62.850	-3.211***
Tenure	5.983	8.380	-2.397***
Field_business	0.463	0.485	-0.022***
Field_law	0.138	0.135	0.004*
Field_medicine	0.028	0.026	0.002**
Field_STEM	0.400	0.460	-0.060***
# Fields	1.029	1.105	-0.076***
Highest degree	1.828	1.739	0.089***
Obs. (for Tenure, no missing values)	36,897	169,340	

Panel B: Director skill sets

	Group mean for directors		Diff. in mean t-test
	Female	Male	
	(1)	(2)	(3)
Skill_academic	0.171	0.120	0.051***
Skill_community	0.113	0.050	0.063***
Skill_environment	0.035	0.015	0.020***
Skill_government	0.214	0.151	0.063***
Skill_risk mgt	0.077	0.039	0.038***
Skill_tech	0.148	0.131	0.017***
# Skills	0.749	0.500	0.249***
Industry experience	0.230	0.414	-0.184***
Finance experience	0.287	0.301	-0.014***

Panel C: Board leadership and committee affiliations

	Group mean for directors		Diff. in mean t-test
	Female	Male	
	(1)	(2)	(3)
Chairman of the Board	0.015	0.120	-0.105***
Lead director	0.023	0.051	-0.028***
Audit committee	0.492	0.426	0.065***
Compensation committee	0.366	0.355	0.010***
ESG committee	0.053	0.030	0.023***
Nomination committee	0.312	0.268	0.044***

Panel D: Directors' board leadership roles and committee affiliations

	Mean	SD
Chairman of the Board	0.101	0.301
Lead director	0.046	0.209
Audit committee	0.438	0.496
Compensation committee	0.357	0.479
ESG committee	0.034	0.180
Nomination committee	0.276	0.447

Panel E: Key board committees at the firm-year level

	Mean	SD
Audit committee	0.997	0.058
Compensation committee	0.858	0.349
ESG committee	0.069	0.253
Nomination committee	0.652	0.476

Panel F: ESG-linked compensation policy, ESG (executive) committee, and ESG reporting at the firm-year level

	Mean	SD
Compensation policy including ESG metric	0.251	0.434
ESG (executive) committee	0.284	0.451
ESG reporting	0.277	0.447

Table IA7
Female directors and corporate environmental performance: including different fixed effects

This table examines the relation between the share of female directors on a board and corporate environmental performance by including different fixed effects. The dependent variable is *E score*, the average of emissions reduction score, resource use score, and innovation score from Refinitiv. Our variable of interest is *Female director ratio*, the number of female directors scaled by board size. In addition to firm, year, and (three-digit SIC) industry times year fixed effects, we further include the following fixed effects: firm headquarters state times year fixed effects and firm incorporation state times year fixed effects. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

	E score				
	(1)	(2)	(3)	(4)	(5)
Female director ratio	0.108***	0.104***	0.080***	0.071***	0.061**
	(0.024)	(0.025)	(0.026)	(0.023)	(0.026)
Board size	0.005***	0.005***	0.004***	0.003***	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Board independence	-0.126***	-0.114***	-0.144***	-0.093***	-0.119***
	(0.028)	(0.027)	(0.029)	(0.025)	(0.027)
Board busyness	0.008	-0.000	-0.005	-0.016	-0.016
	(0.017)	(0.017)	(0.018)	(0.015)	(0.017)
Female CEO	0.009	0.007	0.009	-0.009	-0.004
	(0.014)	(0.014)	(0.015)	(0.014)	(0.016)
Top5 institutions	-0.033*	-0.025	-0.031	-0.031*	-0.032*
	(0.018)	(0.018)	(0.019)	(0.017)	(0.019)
M/B	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm size	0.021***	0.021***	0.024***	0.023***	0.025***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
ROA	-0.010	-0.016	0.003	-0.018*	-0.007
	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)
Leverage	-0.036**	-0.044***	-0.029*	-0.020	-0.018
	(0.015)	(0.015)	(0.016)	(0.013)	(0.015)
Cash holdings	0.033*	0.034*	0.031	0.025	0.024
	(0.017)	(0.018)	(0.019)	(0.017)	(0.020)
SG&A	0.003	0.004	0.004	-0.002	-0.002
	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes				
Industry × Year Fixed Effects				Yes	Yes
Headquarters state × Year Fixed Effects		Yes		Yes	
Incorporation state × Year Fixed Effects			Yes		Yes
Intercept	Yes	Yes	Yes	Yes	Yes
Obs.	21,488	21,352	19,145	21,338	19,108
Adj-R^2	0.821	0.827	0.825	0.852	0.844

Table IA8
Female directors and corporate environmental performance: additional robustness checks

This table examines the relation between the share of female directors on a board and corporate environmental performance with additional robustness checks. Column (1) examines the possible nonlinear effect of the number of women on a board by introducing indicator variables representing one or more women, two or more women, and three or more women on a board. Columns (2) and (3) examine the possible effect of a board's national cultural values using a sample with directors' ancestral data. Columns (4) and (5) examine the possible effect of a board's political leaning using a sample with directors' donation data. We include (three-digit SIC) industry times year fixed effects and firm fixed effects. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

	E score				
		Sample with directors' ancestral data		Sample with directors' donation data	
	(1)	(2)	(3)	(4)	(5)
Female director count ≥ 1	0.008				
	(0.005)				
Female director count ≥ 2	0.019***				
	(0.005)				
Female director count ≥ 3	0.011**				
	(0.005)				
Female director ratio		0.111***	0.108***	0.088**	0.089**
		(0.028)	(0.027)	(0.037)	(0.037)
Board IDV			0.003		
			(0.103)		
Board UAI			-0.042		
			(0.074)		
Board PDI			-0.114		
			(0.119)		
Board MAS			0.063		
			(0.099)		
Board Democratic share					-0.015
					(0.020)
Board size	0.003**	0.004***	0.004***	0.003*	0.003*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Board independence	-0.126***	-0.140***	-0.140***	-0.167***	-0.167***
	(0.028)	(0.028)	(0.028)	(0.032)	(0.032)
Board busyness	0.008	-0.001	-0.001	-0.006	-0.006
	(0.017)	(0.017)	(0.017)	(0.021)	(0.021)
Female CEO	0.012	0.011	0.010		
	(0.014)	(0.015)	(0.015)		
Top5 institutions	-0.032*	-0.029	-0.030	-0.020	-0.020
	(0.018)	(0.020)	(0.020)	(0.024)	(0.024)
M/B	0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm size	0.021***	0.028***	0.028***	0.027***	0.026***
	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)
ROA	-0.010	-0.003	-0.003	0.015	0.016
	(0.009)	(0.010)	(0.010)	(0.013)	(0.013)
Leverage	-0.035**	-0.032**	-0.033**	-0.031	-0.030
	(0.014)	(0.016)	(0.016)	(0.021)	(0.021)
Cash holdings	0.033*	0.035*	0.035*	0.024	0.024
	(0.017)	(0.019)	(0.019)	(0.024)	(0.024)

SG&A	0.003	0.004	0.004	0.008	0.008
	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
Obs.	21,488	20,372	20,372	15,313	15,313
Adj-R^2	0.822	0.811	0.811	0.8108	0.8108

Table IA9
Female directors and corporate environmental performance: using KLD and ASSET4 data

This table examines the relation between the share of female directors on a board and corporate environmental performance using two other ESG data sets: the KLD and ASSET4 data sets, and the same regression analysis as Table 3 by including (three-digit SIC) industry times year fixed effects and firm fixed effects in different columns. Definitions of the variables are provided in the Appendix. Standard errors (in parentheses) are clustered at the firm level. ***, **, * correspond to statistical significance at the 1, 5, and 10 percent levels, respectively.

	E score_KLD		E score_ASSET4	
	(1)	(2)	(3)	(4)
Female director ratio	0.087***	0.049*	0.234***	0.069**
	(0.020)	(0.026)	(0.038)	(0.034)
Board size	0.004***	0.003***	0.010***	0.002
	(0.001)	(0.001)	(0.002)	(0.001)
Board independence	-0.077***	-0.127***	-0.113***	-0.106***
	(0.014)	(0.021)	(0.032)	(0.028)
Board busyness	0.032***	-0.018	0.089***	-0.014
	(0.011)	(0.014)	(0.018)	(0.014)
Female CEO	-0.006	-0.002	0.005	-0.005
	(0.012)	(0.015)	(0.017)	(0.020)
Top5 institutions	-0.046***	-0.019	-0.082***	-0.023
	(0.015)	(0.017)	(0.026)	(0.023)
M/B	0.001***	0.000	0.001	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Firm size	0.024***	-0.020***	0.064***	0.017***
	(0.002)	(0.005)	(0.004)	(0.006)
ROA	0.022**	0.002	0.018	-0.009
	(0.010)	(0.009)	(0.019)	(0.015)
Leverage	-0.007	0.013	-0.026	0.005
	(0.011)	(0.014)	(0.019)	(0.019)
Cash holdings	0.011	0.020	0.124***	0.004
	(0.011)	(0.013)	(0.025)	(0.023)
SG&A	0.003*	0.003*	-0.007*	-0.004
	(0.002)	(0.002)	(0.004)	(0.004)
Industry × Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects		Yes		Yes
Intercept	Yes	Yes	Yes	Yes
Obs.	23,364	22,850	12,825	12,595
Adj-R^2	0.299	0.530	0.446	0.804

Appendix IA1
Comparing Refinitiv ESG with ASSET4

The excerpt from WRDS provides a brief comparison between Refinitiv and ASSET4 in their scoring approach.

Home / Support / Knowledgebase / Thomson Reuters / ESG / ESG Company Summary table discontinued

ESG Company Summary table discontinued

Refinitiv recommends not using the Company Summary table

Detail

According to Refinitiv Support in April 2022:

"Prior to Q2 2017, the scoring methodology was based on a Z-score. To better optimize and meet the changing needs for relevant and material ESG data across more markets, the methodology changed to use a Percentile scoring methodology. In doing so, some data types became "inactive" and data collection stopped for some measures beginning in 2014 w/ additional stoppage for several measures from 2017 onward. These include the Economic Pillar Score, and content has suggested to not rely on this measure as it contains stale data."

On WRDS, the entire Company Summary table is inactive and should not be used going forward. Certain variables in the other ESG tables have also been set to inactive. Please check the SAS label or the description on the web query pages to see if it is noted inactive. **Inactive variables continue to be updated with new data**. This data is incorrect and inactive items should not be used post 2014. They remain on WRDS for historical reference.

Top of Section

Top

Table of

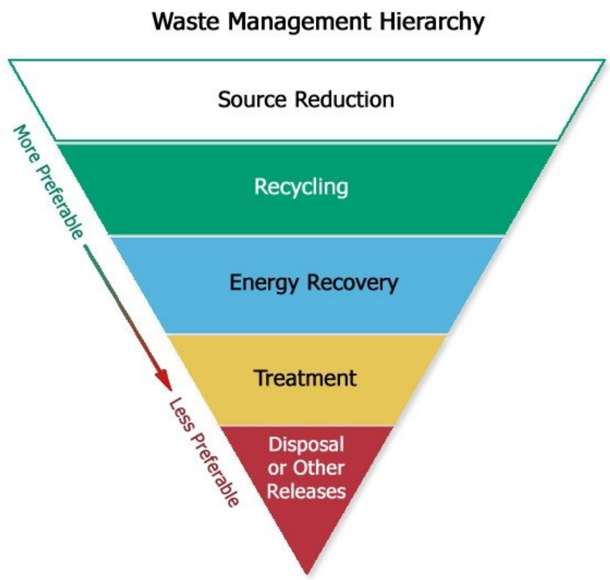
» Detail

Appendix IA2
Introduction to the EPA's TRI database

A. The P2 database

The Pollution Prevention Act (P2 Act) approved by the Congress in 1990 authorized the EPA to gather and disseminate information on pollution prevention activities (also known as source reduction activities). It is under the TRI database (in File Type 2A: https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-plus-data-files-calendar-years-1987-present). Facilities satisfying the following criteria are required to report to the TRI database: (1) in the mining, utility, manufacturing, publishing, hazardous waste, or federal industry; (2) manufacturing, processing, or otherwise using a TRI-listed chemical in quantities above certain threshold levels set by the EPA in a given year; and (3) having ten or more full-time equivalent employees.

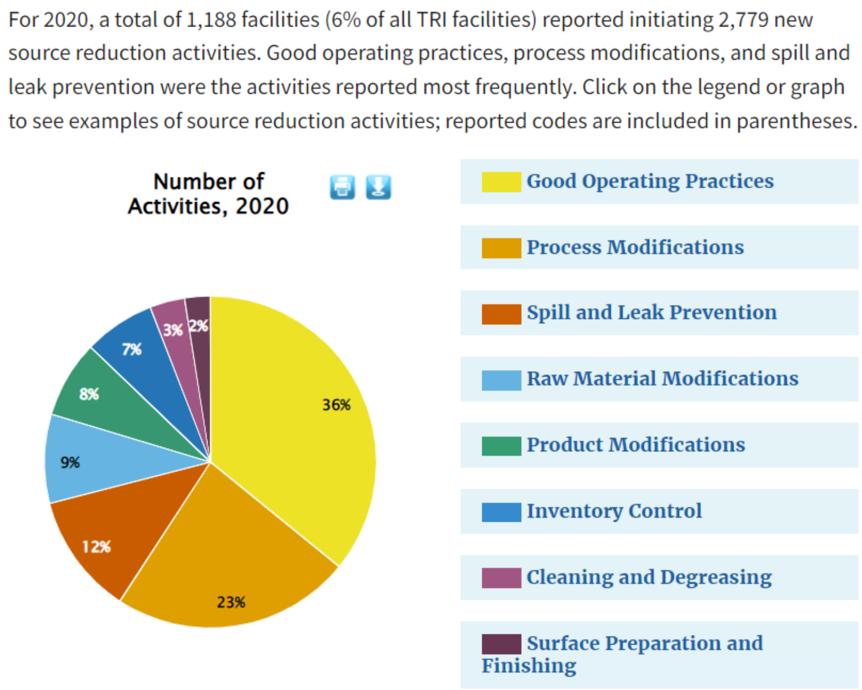
Facilities are required to disclose any source reduction practices implemented at their facilities to reduce production waste in the reporting year. Source reduction practices denote the first layer of the waste management hierarchy (see the figure below): Once potential production waste is reduced, firms do not need to recycle, recover, treat, and release it.



Source: https://www.epa.gov/trinationalanalysis/pollution-prevention-and-waste-management

Facilities report these newly implemented source reduction practices by selecting one or more predefined codes (W-codes) that describe specific practices within the eight categories: raw material modifications, product modifications, cleaning and degreasing, surface preparation and finishing, process modifications, spill and leak prevention, inventory control, and good operating practices (detailed definitions are provided at https://www.epa.gov/toxics-release-inventory-tri-program/pollution-prevention-p2-and-tri). Note that, since 2021, the classification of reduction practices has been changed to a system of S-codes as in Appendix D of this file: https://www.epa.gov/system/files/documents/2021-08/file_type_2a_0.pdf

The following pie chart illustrates the frequencies of eight categories of source reduction practices:



Source: https://www.epa.gov/toxics-release-inventory-tri-program/pollution-prevention-p2-and-tri

B. The Toxics Release Inventory (TRI) database

The TRI program was established by the EPA due to the Emergency Planning and Community Right-to-Know Act (EPCRA) in 1986. The TRI reporting started with the 1987 reporting year (first TRI reports due July 1st, 1988), and has continued to the present. In terms of coverage, we find more comprehensive coverage since 1991. By August 2022, the TRI toxic chemical list contains 775 individually listed chemicals and 33 chemical categories.

Each TRI-reporting facility reports the production and ultimate outlets of each chemicals (see: https://www.epa.gov/toxics-release-inventory-tri-program/common-tri-terms). “Production waste” denotes the amount of all chemicals produced along with the production process. The outlets of those waste include recycling, energy recovery, treatment, and releases (definitions are provided in the above link).
The releases include air releases, water release, and land release (also defined in the above link).

After collecting all facility-level releases data from the EPA website (https://www.epa.gov/toxics-release-inventory-tri-program), we use the link between facility id (TRIFD) to Compustat GVKEY established by Chen et al. (2022) that is based on matching facility names and parental company names.

about ECGI

The European Corporate Governance Institute has been established to improve *corporate governance through fostering independent scientific research and related activities.*

The ECGI will produce and disseminate high quality research while remaining close to the concerns and interests of corporate, financial and public policy makers. It will draw on the expertise of scholars from numerous countries and bring together a critical mass of expertise and interest to bear on this important subject.

The views expressed in this working paper are those of the authors, not those of the ECGI or its members.

Electronic Access to the Working Paper Series

The full set of ECGI working papers can be accessed through the Institute's Web-site (www.ecgi.global/content/working-papers) or SSRN:

Finance Paper Series	http://www.ssrn.com/link/ECGI-Fin.html
Law Paper Series	http://www.ssrn.com/link/ECGI-Law.html