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# Are women greener? Corporate gender diversity and environmental violations

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ABSTRACT

This study examines the relationship between board gender diversity and corporate environmental violations. Drawing on gender socialization and diversity theories, greater female board representation and female chief executive officers (CEO) are expected to reduce the frequency of corporate environmental violations. Empirical evidence in this study shows that firms with greater board gender diversity are less often sued for environmental infringements. In contrast, CEO gender is linked to reduced environmental litigation only in firms with low female board representation. I explore the relationship between board gender diversity and improved corporate environmental policies as a mechanism to explain the reduced litigation frequency. The findings are robust to controlling for reverse causality, propensity score matching, subsample analyses, different variable definitions, alternative model specifications, and industry controls and adjustments. These findings provide important insights to investors, managers, and policymakers into the role of female leadership in public companies.

## 1. Introduction

The last decade has seen an increasing number of female executive officers and directors serving in U.S. public corporations (Catalyst, 2016). However, women remain underrepresented in boardrooms globally (Catalyst, 2017; ISS, 2017). Countries such as Norway and Spain have mandated board gender quotas; elsewhere, regulators and commentators are calling for more female representation on boards (Adams and Funk, 2012). These policies and proposals give rise to a vital need for researchers to examine the benefits associated with gender diversity in corporate leadership.

A body of academic research investigates the "business case" for board and executive gender diversity (e.g., Rose, 2007; Adams and Ferreira, 2009; Adams and Funk, 2012; Cumming et al., 2015). Empirical evidence suggests that firms with more gender-diverse boards have better financial performance (Erhardt et al., 2003; Joecks et al., 2013; Liu et al., 2014), higher market valuation (Campbell and Mínguez-Vera, 2008), and superior governance quality (Adams and Ferreira, 2009). Two prevailing theories explain the mechanisms by which value is added by gender diversity in the boardroom (e.g., Erhardt et al., 2003; Cumming et al., 2015). First, gender socialization theory suggests that women, as a result of their upbringing, are more community-minded and caring towards others (Carlson, 1972; Gilligan, 1977; Eagly and Crowley, 1986). This enables female executives and directors to better manage stakeholder relationships (Adams et al., 2011; McGuinness et al., 2017). Second, women bring different perspectives to the boardroom, and such diversity of opinion improves board dynamics and enhances group decision-making (Erhardt et al., 2003; Westphal and Bednar, 2005).

Consistently, empirical evidence links corporate gender diversity to specific value-enhancing corporate policies, such as greater

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innovation (Torchia et al., 2011), share buybacks (Evgeniou and Vermaelen, 2017), and corporate social responsibility (CSR) initiatives (Bear et al., 2010; Post et al., 2011; Jia and Zhang, 2013; McGuinness et al., 2017). Gender diversity is also associated with reduced empire-building through acquisitions (Huang and Kisgen, 2013; Levi et al., 2014; Chen et al., 2016a), and fewer incidences of unethical conduct such as tax avoidance (Lanis et al., 2015; Richardson et al., 2016) and accounting misreporting (Cumming et al., 2015; García Lara et al., 2017). However, no prior study has examined whether gender diversity reduces the level of corporate environmental misconduct. Environmental violations not only have significant impacts on societies, but can also cause devastating losses of shareholder value (e.g., Clarke, 2017). In light of the increasing importance of corporate environmental responsibility (Flammer, 2015; Fernando et al., 2017), this study's investigation into the link between corporate gender diversity and firms' likelihood of breaching environmental laws is timely and significant.

Drawing on gender socialization theory, diversity theory, and the literature on overconfidence, I hypothesize that firms with greater female board representation and female CEOs are less often sued for environmental violations. Gender socialization theory suggests that women are more concerned with the welfare of stakeholders, making them more likely to take action to preempt environmental risks that can harm communities (Carlson, 1972; Gilligan, 1977; Adams et al., 2011). Under diversity theory, female directors bring different perspectives and offer a wider range of eco-friendly solutions, which improves board decision-making on environmental issues (Erhardt et al., 2003; Westphal and Bednar, 2005; Cumming et al., 2015; Estélyi and Nisar, 2016). Finally, prior studies show that women executives and directors are less overconfident and more likely to seek expert advice than their male counterparts (Huang and Kisgen, 2013; Levi et al., 2014, 2015); both traits are expected to reduce firms' exposure to environmental risks.

To test these hypotheses, I examine all environmental lawsuits filed against the Standard and Poor's 1500 (S&P 1500) firms in United States (U.S.) Federal Courts during 2000–2015. Environmental lawsuits, which capture the alleged harm done in violation of the law, constitute the most direct proxy for corporate environmental misconduct. Unlike CSR ratings, litigation proxies are not susceptible to corporate manipulation through "greenwashing", whereby firms adopt eco-friendly CSR initiatives to boost the number of environmental "strengths" without addressing more potent "concerns" by refraining from eco-harmful operations (e.g., Laufer, 2003; Walker and Wan, 2012; Prasad and Holzinger, 2013; Matejek and Gössling, 2014).

I employ tobit models to predict the frequency of environmental lawsuits, using the proportion of female directors on the board and CEO gender as explanatory variables. However, the selection of female directors and CEOs may be endogenous, since women executives and directors might choose to join environmentally-friendly firms. I address the issue of endogeneity using three different approaches. First, to deal with potential reverse causality, I follow Dittmann et al. (2010) and Joecks et al. (2013) and use lagged independent variables (representing gender diversity) to predict environmental lawsuits. Second, following Francis et al. (2014), I employ a propensity score matching approach to deal with potential endogeneity by pair-matching firm-year observations with high versus low female board representation (above/equal or below the sample median). Third, I include industry fixed effects in all regression models and employ industry-adjusted dependent and explanatory variables in the robustness analysis.

The empirical results of this study provide support for the hypothesized relationship between board gender diversity and environmental litigation. Firms with greater female board representation experience significantly fewer environmental lawsuits. Female CEOs are also significantly associated with reduced environmental lawsuits, but only within a subsample of firms that have low board gender diversity. In addition, the results demonstrate that one mechanism through which board gender diversity can reduce environmental lawsuits is by improving corporate environmental policies, as proxied by Kinder Lydenberg Domini (KLD) environmental ratings. The empirical results are robust to a series of additional tests, including subsample analyses, alternative variable definitions and model specifications, industry controls and adjustments, a propensity score matching approach, and replication of prior studies' results using gender diversity to predict securities fraud (Cumming et al., 2015).

These findings contribute to the existing literature in three important ways. First, this study adds to the gender literature investigating how female executives and directors can affect corporate policies, which informs global policies promoting corporate gender diversity (e.g., Erhardt et al., 2003; Campbell and Mínguez-Vera, 2008; Adams and Ferreira, 2009; Adams et al., 2011; Joecks et al., 2013; Liu et al., 2014; Cumming et al., 2015). Prior studies document the link between corporate gender diversity and a greater number of positive CSR initiatives (or "strengths") (Bear et al., 2010; Post et al., 2011; McGuinness et al., 2017). However, no existing evidence has investigated actual environmental *misconduct* committed by firms. This study employs lawsuits as a direct measure of environmental performance and documents novel evidence that corporate gender diversity is associated with a lower frequency of alleged environmental violations.

Second, this paper adds to the literature that predicts firms' risks and exposure to environmental liabilities (Kassinis and Vafeas, 2002; Buysse and Verbeke, 2003; Kassinis and Vafeas, 2006; Flammer, 2013; Fernando et al., 2017). Prior studies have examined the corporate governance consequences of environmental violations (Aharony et al., 2015; Liu et al., 2016; Liu and Yawson, 2018). Given the significant loss of shareholder wealth associated with environmental lawsuits (Bhagat et al., 1998; Karpoff et al., 2005), how firms can reduce the likelihood of litigation remains an important empirical question. This paper documents that board gender diversity is associated with reduced environmental lawsuits, adding to existing evidence on the role of board composition in predicting environmental litigation risk (e.g., McKendall, 1999; Kassinis and Vafeas, 2002; Walls et al., 2012).

Third, this paper provides additional insights into the interplay between board gender diversity and CEO gender. Prior studies document a critical threshold of at least three women on a board before they can significantly influence corporate decision-making (Post et al., 2011; Torchia et al., 2011; Joecks et al., 2013; Liu et al., 2014). I find evidence of the complementary roles served by female directors and female CEOs in directing corporate policies to reduce environmental exposure. In particular, female CEOs are associated with reduced environmental lawsuits *only* in firms with low female board representation; conversely, in firms led by male CEOs, a stronger relationship is observed between the proportion of female directors and reduced litigation frequency. These findings provide further insights into the way in which female executives and directors interact in corporate decision-making.

The findings from this study also offer significant implications for investors, managers, and policymakers. Given the growing awareness of the importance of corporate social responsibility (Flammer, 2015; Ferrell et al., 2016; Bhandari and Javakhadze, 2017; Fernando et al., 2017), the presence of female directors serves as a potent signal to investors who are environmentally conscious. Additionally, the empirical evidence in this study informs the ongoing debates in many countries over the business-case justifications for mandating board gender quotas.

The remainder of the paper is organized as follows: Section 2 reviews prior literature and develops the research hypotheses. Section 3 details the sample selection process and research methodology. Section 4 presents and discusses the empirical results, and Section 5 concludes.

## 2. Literature and hypothesis development

### 2.1. Gender and corporate policies

Gender plays an important role in influencing individuals' decision-making (Ryan, 2017). In a corporate setting, CEO gender and female board representation are significant determinants of firm policies (e.g., Adams and Ferreira, 2009; Huang and Kisgen, 2013; Levi et al., 2014; Cumming et al., 2015; Chen et al., 2016a). Prior studies have examined the impact of board gender diversity on firms' financial performance (e.g., Erhardt et al., 2003; Campbell and Mínguez-Vera, 2008; Adams and Ferreira, 2009; Liu et al., 2014). Greater female representation on boards is linked to better financial returns and higher market valuation (e.g., Erhardt et al., 2003; Campbell and Mínguez-Vera, 2008). However, Adams et al. (2009) argue that this link exists only in firms with poorer corporate governance (as proxied by stronger takeover defenses). Further, there is evidence of a non-linear relationship between the number of women on boards and financial performance; the presence of one or two "token" women on a board is associated with poorer firm performance, whereas three or more women (reaching a critical mass) are associated with improved firm performance (Joecks et al., 2013; Liu et al., 2014). In relation to specific corporate policies, firms with greater board gender diversity engage in more innovations (Torchia et al., 2011), more share buybacks (Evgeniou and Vermaelen, 2017), and less empire building through acquisitions (Huang and Kisgen, 2013; Levi et al., 2014; Chen et al., 2016a).

Prior studies also find that higher female board representation is associated with better CSR ratings (Bear et al., 2010; Post et al., 2011; McGuinness et al., 2017). Bear et al. (2010) document that, within the healthcare industry, firms with more women on the board have a greater number of positive CSR initiatives (or "strengths") recorded in the Kinder Lydenberg Domini (KLD) ratings. Similarly, Post et al. (2011) document that the presence of three or more female directors is associated with higher environmental strength scores. However, positive environmental CSR strengths and negative environmental problems ("or concerns") may have asymmetric impacts on firms (Flammer, 2013; Krüger, 2015). Moreover, CSR ratings are vulnerable to corporate greenwashing (Bansal and Kistruck, 2006; Barnett and Salomon, 2012; Zyglidopoulos et al., 2012), whereby a company may strategically use environmentally-friendly initiatives to achieve a high CSR "strengths" score and improve its perceived environmental reputation, without refraining from eco-harmful conduct. Consequently, an examination of actual environmental performance, rather than perceived reputation, is warranted. To capture corporate environmental misconduct, I examine legal allegations filed against the sample firms for breaching environmental laws.

### 2.2. Corporate environmental performance and financial performance

Debates persist over whether corporate environmental performance improves financial performance (Horváthová, 2010; Endrikat et al., 2014). On the one hand, stakeholder theory argues that environmental CSR enhances firm value by appropriately managing stakeholder relationships (Williamson, 1985; Donaldson and Preston, 1995; Jones, 1995) and eliminating the inefficiency of pollution (Porter and van der Linde, 1995a, 1995b). Consistent with this view, some empirical evidence shows that superior environmental policies are positively associated with financial valuation (Konar and Cohen, 2001; Clarkson et al., 2011; Eccles et al., 2014; Ferrell et al., 2016; Fernando et al., 2017; Miroshnychenko et al., 2017). On the other hand, some argue that pursuing environmental protection destroys firm value, as evidenced by a negative association between firms' environmental and financial performance (Jaggi and Freedman, 1992; Di Giuli and Kostovetsky, 2014; Gonenc and Scholtens, 2017). Some studies document no evidence that CSR efforts translate into financial gains (King and Lenox, 2002; Crilly et al., 2016), whereas others find the relationship between environmental and financial performance to be non-linear (Horváthová, 2012; Misani and Pogutz, 2015; Chen et al., 2016b) and non-homogeneous (Bhandari and Javakhadze, 2017)[1]: it varies across different initiatives (Iwata and Okada, 2011; Nishitani et al., 2017), industries (Qi et al., 2014; Lucas and Noordewier, 2016), and economic conditions (Muhammad et al., 2015; Feng et al., 2016).

Notwithstanding the mixed evidence on whether environmental strategies improve financial performance, corporate environmental responsibility is undeniably an issue of growing importance in modern boardrooms (e.g., Krüger, 2015; Ferrell et al., 2016; Fernando et al., 2017). Societal and academic perceptions of corporate environmental protection and sustainability have shifted over time (Porter and van der Linde, 1995b). The last three decades have seen a dramatic increase in pressure, exerted by both investors and consumers, on firms to behave in an environmentally responsible way (Flammer, 2013; Ioannou and Serafeim, 2015; Luchs and

[1] The measures of environmental performance are far from standardized in the literature (e.g., McKendall, 1999; Konar and Cohen, 2001; Tole and Koop, 2011).

Kumar, 2017). For example, from 1980 to 2009, market participants have grown to expect more eco-friendly corporate initiatives, as evidenced by their decreasing positive marginal returns; and eco-harmful activities have triggered greater valuation losses in more recent years, indicating investors' heightened sensitivity and reduced tolerance of environmental misconduct (Flammer, 2013). These changes in investor attitude are mirrored by those of financial analysts (Ioannou and Serafeim, 2015). Since the early 1990s, analysts' perceptions of firms with high CSR ratings have become progressively more optimistic, reflecting the growing importance of CSR to firm valuation (Ioannou and Serafeim, 2015). In the light of these social and cultural shifts towards a greater emphasis on corporate environmental protection, this paper provides timely evidence on the role of female corporate leadership in predicting environmental misconduct, notwithstanding the inconclusive empirical evidence on whether it is financially advantageous for firms to refrain from environmental violations.

### 2.3. Gender and corporate environmental misconduct

The board of directors plays an important role in formulating corporate environmental policies that direct a firm's strategic activities in managing its impacts on the environment (Walls et al., 2011; Walls et al., 2012). Research has produced mixed evidence on the relationship between corporate governance characteristics, such as board composition, and firm environmental performance (McKendall, 1999; Kassinis and Vafeas, 2002; Walls et al., 2012). Some researchers find that board size and independence significantly determine firms' environmental CSR ratings (Walls et al., 2012) and litigation risks (Kassinis and Vafeas, 2002), whereas others find no evidence that board independence is significantly associated with the frequency of environmental violations (McKendall, 1999). No prior studies have examined the link between gender diversity in corporate leadership and corporate environmental misconduct. Several theoretical and empirical perspectives suggest that women are expected to outperform men in decision-making on environmental issues to avoid lawsuits (Cumming et al., 2015). These include gender socialization theory, diversity theory, and the literature on overconfidence.

#### 2.3.1. Gender socialization and universalism

Gender socialization theory suggests that women and men have different perspectives on ethical issues as a result of early experiences through social interactions (Gilligan, 1982). Women are raised to be more aware and caring regarding the needs of others (Carlson, 1972) and to show greater sensitivity towards ethical issues (Simga-Mugan et al., 2005; Ibrahim et al., 2009).

Empirical evidence demonstrates gender differences in ethical decision-making (e.g., Dawson, 1997; Radtke, 2000; Valentine and Rittenburg, 2007; Ibrahim et al., 2009; Puncheva-Michelotti et al., 2010; Ryan, 2017). For example, Ibrahim et al. (2009) find that female executives are more receptive to a code of ethics than their male counterparts. These individual-level differences are reflected in firm-level policies; firms with gender-diverse boards are less likely to engage in unethical conduct, such as securities fraud (Cumming et al., 2015), earnings management (García Lara et al., 2017), and tax avoidance (Lanis et al., 2015; Richardson et al., 2016).

In the boardroom context, female executives and directors bring different ethical values and traits to decision-making (Robin and Babin, 1997). Adams and Funk (2012) show that female directors are less power-oriented than their male counterparts and have strong traits of benevolence and universalism, which encompass "understanding, appreciation, tolerance and protection for the welfare of all people and for nature" (Adams et al., 2011, p. 1334). Consistently, empirical evidence shows that female representation on boards is associated with more corporate charitable donations (Jia and Zhang, 2013) and more positive CSR initiatives (Bear et al., 2010; Post et al., 2011).

Adams et al. (2011) argue that directors and CEOs with lower power-oriented values and higher universalism show greater concern for stakeholders beyond shareholders. Following this logic, I posit that female directors, who are characterized by high universalism and low power-orientation (Adams and Funk, 2012), are more likely to have concern for wider stakeholder groups. Environmental lawsuits are unique in that the plaintiffs are commonly third-parties, such as local communities and residents, who have no existing contractual relationships with the offending firms (Karpoff et al., 2005) (in contrast to securities lawsuits brought by shareholders, contractual lawsuits by trading partners, or product liability suits by customers). Therefore, since female directors and CEOs are more concerned about the welfare of third-party stakeholders affected by eco-harmful activities, they are more likely to formulate strategies to avoid environmental violations.

Moreover, if female corporate leaders are indeed driven by gender-based universalistic and benevolent values to prevent corporate environmental misconduct out of concern for others, then one should expect this to occur *regardless* of whether their firms can derive economic benefits from doing so. In other words, under gender socialization and ethicality theories, this hypothesized relationship is expected to exist independent of any proven link between corporate environmental and financial performance, which remains inconclusive in the literature (e.g., Di Giuli and Kostovetsky, 2014; Misani and Pogutz, 2015; Ferrell et al., 2016; Fernando et al., 2017).

#### 2.3.2. Diversity and group performance

Diversity theory suggests that the process of corporate decision-making can benefit from different backgrounds and perspectives among the decision-makers (Siliciano, 1996; Erhardt et al., 2003; Estélyi and Nisar, 2016). For example, Erhardt et al. (2003) find that both gender and ethnic diversity improve firm financial performance. Campbell and Mínguez-Vera (2008) argue that demographic diversity on corporate boards enhances decision-making outcomes through three mechanisms: (i) better understanding of different stakeholder groups, (ii) greater creativity and innovation, and (iii) a wider range of perspectives being canvassed, resulting in more options being evaluated to identify an optimal solution (which would not occur within a homogenous group). In addition, Cumming et al. (2015) argue that gender diversity reduces the level of trust on a board, thus enhancing board monitoring quality. Cumming et al. (2015) find consistent evidence that firms with greater female board representation are less likely to commit securities fraud.

Following similar logic, I argue that, in the context of environmental issues, board gender diversity should improve the quality of corporate decision-making for two reasons. First, female directors bring different perspectives in relation to managing environmental exposure, with particular concern for third-party stakeholders. This enables boards to evaluate a broader range of environmentally-friendly options to minimize litigation risk. These diverse perspectives also potentially allow the board to take into account non-economic considerations beyond the impact of improving environmental performance on firm financial performance. Secondly, greater female board representation can disrupt existing trust relationships among directors (Cumming et al., 2015), thus reducing the level of complacency regarding environmental policies and practices, which leads to higher quality decision-making to avoid violations and consequent litigation.

### 2.3.3. *Overconfidence and receptiveness to expert advice*

Women are generally perceived to be more risk averse (Jianakoplos and Bernasek, 1998; Cumming et al., 2015). However, in the boardroom context, survey evidence shows that female directors are less risk averse than their male colleagues, contrary to the gender trait associated with the general population (Adams and Funk, 2012). Nonetheless, women executives and directors exhibit less overconfidence than their male counterparts (Huang and Kisgen, 2013; Levi et al., 2014; Chen et al., 2016a). Specifically, firms with greater female board representation, and those led by female executives, tend to engage in fewer acquisitions and debt issuances (Huang and Kisgen, 2013; Chen et al., 2016a), and are less likely to overestimate acquisition gains (Levi et al., 2014). Prior evidence shows that overconfident CEOs are more likely to engage in socially irresponsible actions (Tang et al., 2015). Therefore, I posit that firms with gender-diverse boards and female CEOs, who are less overconfident, are less likely to underestimate the risk of environmental lawsuits and liabilities.

Furthermore, consistent with conventional wisdom that women are more open than men to seeking advice (e.g., asking for directions or obtaining medical advice), Levi et al. (2015) find that gender-diverse boards are more likely to seek expert opinions to inform major corporate decisions, such as engaging top-ranked financial advisors in merger and acquisition (M&A) transactions. When dealing with exposure to potential environmental liabilities, technical expert opinions and recommendations are important to help executives and boards assess and manage risks. The willingness of female executives and directors to seek and implement expert advice is an important factor that can lead to a reduction in the risk of breaching environmental laws. Based on these three mechanisms discussed above, the research hypotheses are specified as follows:

**H1.** Firms with a higher proportion of female directors on their boards experience fewer environmental lawsuits, *ceteris paribus*.

**H2.** Firms with female CEOs experience fewer environmental lawsuits, *ceteris paribus*.

## 3. Data and methodology

### 3.1. *Sample and data*

I employ a sample of all Standard and Poor's 1500 (S&P1500) firms with available data from the Executive Compensation (“Execucomp”) Database during 2000–2015. After excluding firm-year observations with missing data from Compustat or ISS Director and Corporate Governance Databases, the final sample consists of 16,360 firm-years and 2001 unique firms. I collect data on environmental lawsuits from the Public Access to Court Electronic Records (PACER) Database. PACER holds records of all lawsuits filed in the U.S. Federal Courts. I search for all environmental lawsuits filed between January 1, 2000 and December 31, 2015. From the initial pool of 13,632 lawsuits, I match the first-name defendants in the lawsuits with the names of the sample firms, generating 1893 matched lawsuits filed against 571 firm-years (or 221 unique firms) during the sampling period. The sample lawsuits commonly contain allegations under the *Clean Water Act 1972*, the *Clean Air Act 1963*, the *Comprehensive Environmental Response, Compensation, and Liability Act 1980*, and the *Resource Conservation and Recovery Act 1976*. Typical alleged infractions involve water pollution, air pollution, hazardous waste disposal, and restoration actions to remedy land contamination. I collect accounting data from Compustat, and institutional holdings data from ISS Corporate Governance Database. Executive and director information is obtained by merging data from the Execucomp and ISS Director Databases.

### 3.2. *Empirical measures*

To test H1, I calculate the key explanatory variable that measures board gender diversity, *female*, as the proportion of female directors on the board in a given year (the number of female directors divided by the total number of directors), consistent with prior studies (Levi et al., 2014; Cumming et al., 2015; Chen et al., 2016a). To test H2, CEO gender is captured by a binary variable, *femceo*, which equals one if the firm has a female CEO and zero otherwise. In the robustness analysis, pursuant to critical mass theory (Post et al., 2011; Torchia et al., 2011; Jia and Zhang, 2013; Joecks et al., 2013), I use an alternative board gender diversity variable, *female3*, which equals one if there are three or more female directors on the board and zero otherwise. This produces consistent results. All board gender diversity and CEO gender variables are lagged by t-1, t-2, and t-3 years to deal with potential reverse causality (Dittmann et al., 2010; Joecks et al., 2013). In addition, lagged gender variables are used to accommodate the potential time elapsed between the occurrence or discovery of an environmental violation and the filing of a lawsuit. Preparing a legal case can be a time-consuming process; however, in many instances, there is minimal delay between an environmental violation and the lawsuit filing. This is demonstrated by the lawsuits over BP's Gulf of Mexico oil spill. The explosion occurred at the Deepwater Horizon oil rig on 20 April 2010 and, within two months, 220 lawsuits were filed against BP (Jarvis, 2010). However, the size of the time lag can vary substantially from case to case. In order to account for this, I use lagged gender variables from several different periods (years t-3, t-2, and t-1) to enable a more comprehensive examination of the hypothesized relationships under H1 and H2.

The dependent variable *env* measures the number of environmental lawsuits filed in year t. I match each lawsuit to a firm-year observation based on the filing date of the lawsuit. A firm might encounter multiple lawsuit filings in the same year. In the robustness analysis, I employ an alternative dependent variable, *envd*, which equals one if one or more environmental lawsuit(s) is/are filed in year t and zero otherwise. All variables are defined in Appendix A and all non-binary variables are winsorized at the 1st and 99th percentiles.

I employ a series of control variables, including firm size (*LogTA*), performance as proxied by return on assets (*ROA*), debt-to-equity ratio (*leverage*), growth potential as proxied by market-to-book ratio (*marketbook*), cash holdings scaled by total assets (*cash*), bankruptcy risk proxied by Altman's Z score (e.g., Bradley et al., 2016), and firm valuation (*TobinQ*) (e.g., Levi et al., 2014). I also control for corporate governance quality as proxied by board characteristics, including size (*boardsize*) and the proportion of independent directors (*boardindep*), which are significant determinants of firm environmental performance (Kassinis and Vafeas, 2002; De Villiers et al., 2011; Walls et al., 2012). In addition, I control for institutional block-holdings (*blockhold*), because not only can institutional investors impact on firms' litigation risks (Pukthuanthong et al., 2017), but they also play an important role in improving gender diversity in corporate leadership (Bloxham, 2016). Finally, the duration of CEO tenure (*tenure*) is included as a control variable, given the existing evidence that female executives are more likely to be appointed by firms already facing problems (Haslam and Ryan, 2008; Adams et al., 2009), such as impending lawsuits.

### 3.3. Regression models

I run tobit models as specified in Eqs. (1) and (2) below to test H1 and H2, respectively. I use tobit models rather than Ordinary Least Square (OLS) models because of left-censoring in the dependent variable, which contains a large number of zero values. I employ year and industry fixed effects (based on the one-digit Standard Industry Classification (SIC) code).[2]

$$\begin{aligned} Env_{i,t} = {} & \alpha + \beta_1 female_{i,t-1|t-2|t-3} + \beta_2 LogTA_{i,t-1} + \beta_3 ROA_{i,t-1} + \beta_4 leverage_{i,t-1} + \beta_5 marketbook_{i,t-1} + \beta_6 cash_{i,t-1} + \beta_7 TobinQ_{i,t-1} \\ & + \beta_8 AltmanZ_{i,t-1} + \beta_9 boardsize_{i,t-1} + \beta_{10} boardindep_{i,t-1} + \beta_{11} blockhold_{i,t-1} + \beta_{12} tenure_{i,t-1} + \sum industry_t^i + \sum year_t^i \\ & + \varepsilon_{it} \end{aligned} \tag{1}$$

$$\begin{aligned} Env_{i,t} = {} & \alpha + \beta_1 femceo_{i,t-1|t-2|t-3} + \beta_2 LogTA_{i,t-1} + \beta_3 ROA_{i,t-1} + \beta_4 leverage_{i,t-1} + \beta_5 marketbook_{i,t-1} + \beta_6 cash_{i,t-1} + \beta_7 TobinQ_{i,t-1} \\ & + \beta_8 AltmanZ_{i,t-1} + \beta_9 boardsize_{i,t-1} + \beta_{10} boardindep_{i,t-1} + \beta_{11} blockhold_{i,t-1} + \beta_{12} tenure_{i,t-1} + \sum industry_t^i + \sum year_t^i \\ & + \varepsilon_{it} \end{aligned} \tag{2}$$

Additionally, in the robustness analyses, I re-run these equations using Poisson regression models and logit regressions; the latter predict a binary dependent variable *envd* in lieu of *env*. These alternative regression specifications produce consistent results (see Section 4.6.7 below).

### 3.4. Endogeneity

Endogeneity is a potential concern because female director and executive appointments are not randomly determined. I employ the following methodological approaches to deal with the potential issue of endogeneity. First, women directors might self-select to join firms that are more environmentally friendly, giving rise to the potential problem of reverse causality. Following the approach employed by Dittmann et al. (2010) and Joecks et al. (2013), I use lagged independent variables (female board representation and CEO gender) in the empirical models (by one, two, and three years), to eliminate the possibility of the results being driven by reverse causality.

Second, I employ a propensity score matching approach to eliminate heterogeneities between firms with high and low gender diversity. Prior evidence shows that women are more likely to join larger boards, and firms that are less risky, with higher growth, and better performance (Mateos de Cabo et al., 2012; Liu et al., 2014). Accordingly, I divide the firms into two groups, high versus low gender diversity, based on whether the lagged proportion of female directors in year t-1 is above/equal or below the sample median. I then pair-match the firms from the high- and low-gender diversity groups within each year, using industry (one-digit SIC code) and the following firm characteristics as matching criteria (all lagged by one year): board size, board independence, risk (proxied by leverage), growth (proxied by market-to-book ratio), performance (proxied by ROA), firm size (total assets), cash

[2] As a robustness analysis, I re-estimate the baseline regressions in Eqs. (1) and (2) by including *two-digit* SIC codes rather than one-digit SIC codes. As reported in Table 11 and discussed in Section 4.6.5, the estimated coefficients and statistical significance of the key independent variables remain consistent with the baseline results.

**Table 1**
Descriptive statistics.

| Variable | N | Mean | Median | Std. dev. | Maximum | Minimum |
|---|---|---|---|---|---|---|
| Env | 16,360 | 0.049 | 0.000 | 0.352 | 9.000 | 0.000 |
| $Female_{(t-1)}$ | 16,360 | 0.110 | 0.111 | 0.095 | 0.375 | 0.000 |
| $Femceo_{(t-1)}$ | 16,360 | 0.027 | 0.000 | 0.162 | 1.000 | 0.000 |
| $Female_{(t-2)}$ | 15,348 | 0.106 | 0.111 | 0.094 | 0.375 | 0.000 |
| $Femceo_{(t-2)}$ | 15,348 | 0.024 | 0.000 | 0.153 | 1.000 | 0.000 |
| $Female_{(t-3)}$ | 14,329 | 0.104 | 0.100 | 0.092 | 0.364 | 0.000 |
| $Femceo_{(t-3)}$ | 14,329 | 0.021 | 0.000 | 0.145 | 1.000 | 0.000 |
| LogTA | 16,360 | 7.640 | 7.502 | 1.527 | 12.297 | 3.897 |
| ROA | 16,360 | 0.045 | 0.052 | 0.097 | 0.272 | −0.530 |
| Leverage | 16,360 | 1.540 | 1.067 | 2.508 | 22.939 | −7.942 |
| Marketbook | 16,360 | 3.016 | 2.193 | 3.044 | 20.048 | −4.452 |
| Cash | 16,360 | 0.116 | 0.071 | 0.129 | 0.696 | 0.001 |
| AltmanZ | 16,360 | 4.746 | 3.515 | 4.774 | 33.597 | −4.362 |
| TobinQ | 16,360 | 1.980 | 1.572 | 1.258 | 8.672 | 0.731 |
| Boardsize | 16,360 | 9.175 | 9.000 | 2.286 | 17.000 | 3.000 |
| Boardindep | 16,360 | 0.730 | 0.750 | 0.152 | 0.923 | 0.222 |
| Blockhold | 16,360 | 0.139 | 0.062 | 0.196 | 1.111 | 0.000 |
| Tenure | 16,360 | 8.121 | 6.000 | 7.119 | 36.000 | 0.000 |

This table reports the descriptive statistics of the variables included in the baseline regressions. All variables are defined in Appendix A.

holdings, institutional block-holdings, and duration of CEO tenure. I then re-run Eqs. (1) and (2) using the propensity score-matched sample to deal with potential heterogeneities between firms with high and low board gender diversity.

Finally, the association between corporate gender diversity and environmental litigation may be driven by industry variations. I employ three empirical approaches to deal with this concern. First, I include industry fixed effects in all regressions reported in this study. Second, as an untabulated robustness test, I re-run the baseline regressions using an ordinary least squares (OLS) model with industry-clustered standard errors and produce consistent results. Finally, in the robustness section, I re-estimate Eqs. (1) and (2) using industry-adjusted dependent and key explanatory variables, which also produces similar results.

## 4. Empirical results

### 4.1. Descriptive statistics

Table 1 reports the descriptive statistics of the 16,360 firm-year observations employed in the baseline regression analysis. On average, firms experience 0.049 environmental lawsuits per year. The sample firms average 11% female directors on their boards, with a maximum of 37.5% and a minimum of 0%. Only 2.7% of the firm-year observations have female CEOs.

Table 2 reports the industry breakdown using the one-digit SIC code. Column (1) reports the distribution of the number of firm-year observations. As reported in Column (2), the Mining and Oil industry is the most litigation-prone industry in the sample, with firms on average experiencing 0.094 lawsuits per year. This is followed by the Transport, Communications, Electric and Gas industry group (averaging 0.082 lawsuits per firm-year) and Manufacturing (averaging 0.064 lawsuits per firm-year). The industries with the highest board gender diversity are Retail Trade (with 15.1% of female directors), Financial, Insurance, and Real Estate (13.5% female directors), and Transport, Communications, Electric and Gas (13.3% female directors) (Column (3), Table 2). In contrast, Mining and

**Table 2**
Industry breakdown.

| Industry | SIC code | Observations | Env (mean) | $Female_{(t-1)}$ (mean) | $Femceo_{(t-1)}$ (mean) |
|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) |
| Agriculture forestry fishing | 1 | 29 | 0.000 | 0.086 | 0.000 |
| Mining oil | 2 | 786 | 0.094 | 0.066 | 0.000 |
| Construction | 3 | 97 | 0.041 | 0.082 | 0.000 |
| Manufacturing | 4 | 8105 | 0.064 | 0.103 | 0.024 |
| Transportation communications electric gas | 5 | 1970 | 0.082 | 0.133 | 0.018 |
| Wholesale trade | 6 | 622 | 0.010 | 0.106 | 0.000 |
| Retail trade | 7 | 1570 | 0.012 | 0.151 | 0.061 |
| Finance insurance real estate | 8 | 508 | 0.008 | 0.135 | 0.043 |
| Services | 9 | 2651 | 0.003 | 0.102 | 0.034 |
| Nonclassifiable | 11 | 22 | 0.000 | 0.103 | 0.000 |
| Full sample | | 16,360 | 0.031 | 0.107 | 0.018 |

This table reports the industry breakdown of the sample by the one-digit Standard Industry Classification (SIC) code. All variables are defined in Appendix A.

**Table 3**
Univariate analysis.

Panel A: Univariate analysis by board gender diversity (median split)

| Variable | High board gender diversity | | | Low board gender diversity | | | Differences | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | N | Mean | SD | N | Mean | *p*-value |
| Env | 0.053 | 0.358 | 9576 | 0.043 | 0.342 | 6784 | 0.011* | −0.057 |
| $Femceo_{(t-1)}$ | 0.045 | 0.208 | 9576 | 0.001 | 0.024 | 6784 | 0.045*** | 0.000 |
| LogTA | 7.958 | 1.503 | 9576 | 7.192 | 1.445 | 6784 | 0.765*** | 0.000 |
| ROA | 0.051 | 0.088 | 9576 | 0.037 | 0.109 | 6784 | 0.013*** | 0.000 |
| Leverage | 1.728 | 2.705 | 9576 | 1.275 | 2.175 | 6784 | 0.453*** | 0.000 |
| Marketbook | 3.144 | 3.242 | 9576 | 2.836 | 2.730 | 6784 | 0.308*** | 0.000 |
| Cash | 0.107 | 0.118 | 9576 | 0.128 | 0.141 | 6784 | −0.021*** | 0.000 |
| AltmanZ | 4.371 | 4.165 | 9576 | 5.274 | 5.477 | 6784 | −0.903*** | 0.000 |
| TobinQ | 1.966 | 1.234 | 9576 | 1.999 | 1.289 | 6784 | −0.034* | −0.094 |
| Boardsize | 9.572 | 2.090 | 9576 | 8.614 | 2.430 | 6784 | 0.958*** | 0.000 |
| Boardindep | 0.758 | 0.140 | 9576 | 0.690 | 0.159 | 6784 | 0.068*** | 0.000 |
| Blockhold | 0.156 | 0.203 | 9576 | 0.115 | 0.183 | 6784 | 0.040*** | 0.000 |
| Tenure | 7.426 | 6.440 | 9576 | 9.101 | 7.876 | 6784 | −1.675*** | 0.000 |

Panel B: Univariate analysis by CEO gender

| Variable | Female CEO | | | Male CEO | | | Differences | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | N | Mean | SD | N | Mean | p-value |
| Env | 0.034 | 0.246 | 439 | 0.049 | 0.354 | 15,921 | −0.015 | −0.214 |
| $Female_{(t-1)}$ | 0.249 | 0.089 | 439 | 0.106 | 0.093 | 15,921 | 0.143*** | 0.000 |
| LogTA | 7.534 | 1.718 | 439 | 7.643 | 1.521 | 15,921 | −0.109 | −0.189 |
| ROA | 0.043 | 0.097 | 439 | 0.045 | 0.097 | 15,921 | −0.002 | −0.599 |
| Leverage | 1.639 | 2.802 | 439 | 1.537 | 2.500 | 15,921 | 0.102 | −0.453 |
| Marketbook | 3.031 | 3.420 | 439 | 3.016 | 3.033 | 15,921 | 0.016 | −0.924 |
| Cash | 0.134 | 0.120 | 439 | 0.115 | 0.129 | 15,921 | 0.019*** | −0.001 |
| AltmanZ | 4.489 | 4.104 | 439 | 4.753 | 4.791 | 15,921 | −0.264 | −0.187 |
| TobinQ | 1.906 | 1.269 | 439 | 1.982 | 1.257 | 15,921 | −0.076 | −0.219 |
| Boardsize | 8.932 | 2.172 | 439 | 9.182 | 2.289 | 15,921 | −0.250** | −0.018 |
| Boardindep | 0.768 | 0.127 | 439 | 0.729 | 0.152 | 15,921 | 0.040*** | 0.000 |
| Blockhold | 0.104 | 0.167 | 439 | 0.140 | 0.197 | 15,921 | −0.036*** | 0.000 |
| Tenure | 5.809 | 5.241 | 439 | 8.184 | 7.153 | 15,921 | −2.376*** | 0.000 |

Panel A reports the results from the univariate analysis by dividing the sample into subsamples with high versus low board gender diversity (by a median-split using the lagged proportion of female directors on the board in year t-1). Panel B reports the results from the univariate analysis by dividing the sample into subsamples with female versus male CEOs (using lagged CEO gender in year t-1). *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Oil has the lowest female board representation (6.6%). Finally, the industries with the highest proportion of female CEOs are Retail Trade (6.1% are female), Financial, Insurance, and Real Estate (4.3%), and Services (3.4%) (Column (4), Table 2). These results indicate that any association between board gender diversity and environmental litigation is not solely driven by industry variations, since some industries (such as Transport, Communications, Electric and Gas) have both high exposure to environmental lawsuits and high board gender diversity.

## 4.2. Univariate analysis

Table 3 presents the univariate analysis results. In Panel A, I divide the observations into two subsamples with high versus low board gender diversity, based on whether the proportion of female directors on the board in year t-1 is above/equal or below the sample median. Firms in the high gender-diversity sample experience marginally higher frequency of environmental lawsuits than firms in the low gender-diversity sample ($p < 0.10$), but this does not take into account other firm characteristics. Firms with more gender-diverse boards are larger, better performers, have higher leverage, lower market-to-book ratios, lower cash holdings, greater risk of bankruptcy, larger and more independent boards, higher institutional holdings, and shorter CEO tenure ($p < 0.01$).[3] In Panel B, I divide the sample by CEO gender in year t-1. There is no evidence of any significant difference in the frequency of environmental lawsuits between firms led by female versus male CEOs. Firms with female CEOs are also more likely to have greater female board representation, higher cash holdings, smaller and more independent boards, lower institutional holdings, and shorter tenure ($p < 0.05$ or better).

[3] To ensure that the regression results are not driven by these firm-level differences, I employ a propensity score matching approach in Section 4.6.6 as a robustness analysis and match firm-year observations from the subsamples that have high versus low gender diversity.

**Table 4**
Board gender diversity, CEO gender, and environmental lawsuits.

| | Board gender diversity | | | CEO gender | | | Board and CEO gender diversity | | | Standardized coefficients |
|---|---|---|---|---|---|---|---|---|---|---|
| | Env (1) | Env (2) | Env (3) | Env (4) | Env (5) | Env (6) | Env (7) | Env (8) | Env (9) | Model (8) (10) |
| $Female_{(t-3)}$ | −0.121*** | | | | | | −0.122*** | | | |
| | (0.000) | | | | | | (0.001) | | | |
| $Female_{(t-2)}$ | | −0.128*** | | | | | | −0.132*** | | −0.033*** |
| | | (0.000) | | | | | | (0.000) | | |
| $Female_{(t-1)}$ | | | −0.111*** | | | | | | −0.116*** | |
| | | | (0.000) | | | | | | (0.000) | |
| $Femceo_{(t-3)}$ | | | | −0.012 | | | 0.004 | | | |
| | | | | (0.288) | | | (0.731) | | | |
| $Femceo_{(t-2)}$ | | | | | −0.010 | | | 0.007 | | 0.003 |
| | | | | | (0.353) | | | (0.542) | | |
| $Femceo_{(t-1)}$ | | | | | | −0.005 | | | 0.011 | |
| | | | | | | (0.695) | | | (0.402) | |
| LogTA | 0.051*** | 0.049*** | 0.047*** | 0.050*** | 0.048*** | 0.046*** | 0.051*** | 0.049*** | 0.047*** | 0.206*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| ROA | 0.011 | 0.011 | 0.011 | 0.010 | 0.007 | 0.007 | 0.014 | 0.011 | 0.011 | 0.003 |
| | (0.623) | (0.580) | (0.569) | (0.677) | (0.718) | (0.708) | (0.557) | (0.575) | (0.560) | |
| Leverage | 0.001 | 0.002 | 0.002 | 0.001 | 0.002 | 0.002 | 0.001 | 0.002 | 0.002 | 0.013 |
| | (0.459) | (0.288) | (0.187) | (0.484) | (0.325) | (0.214) | (0.455) | (0.289) | (0.187) | |
| Marketbook | −0.002* | −0.003** | −0.003** | −0.002* | −0.003** | −0.003** | −0.002* | −0.003** | −0.003** | −0.021** |
| | (0.055) | (0.039) | (0.011) | (0.056) | (0.036) | (0.011) | (0.062) | (0.039) | (0.011) | |
| Cash | −0.012 | −0.008 | −0.004 | −0.012 | −0.004 | −0.002 | −0.016 | −0.009 | −0.005 | −0.003 |
| | (0.476) | (0.589) | (0.756) | (0.490) | (0.780) | (0.910) | (0.347) | (0.577) | (0.736) | |
| TobinQ | −0.012*** | −0.010*** | −0.007*** | −0.012*** | −0.010*** | −0.007*** | −0.011*** | −0.010*** | −0.007*** | −0.032*** |
| | (0.000) | (0.000) | (0.003) | (0.000) | (0.000) | (0.002) | (0.000) | (0.000) | (0.004) | |
| AltmanZ | 0.003*** | 0.002*** | 0.002*** | 0.003*** | 0.003*** | 0.002*** | 0.003*** | 0.002*** | 0.002*** | 0.031*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| Boardsize | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.012 |
| | (0.191) | (0.207) | (0.194) | (0.504) | (0.504) | (0.464) | (0.227) | (0.200) | (0.185) | |
| Boardindep | 0.084*** | 0.082*** | 0.076*** | 0.075*** | 0.070*** | 0.065*** | 0.086*** | 0.082*** | 0.076*** | 0.034*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| Blockhold | −0.051** | −0.044** | −0.048** | −0.055*** | −0.046** | −0.049** | −0.053** | −0.044** | −0.047** | −0.024** |
| | (0.017) | (0.032) | (0.016) | (0.010) | (0.026) | (0.013) | (0.013) | (0.033) | (0.017) | |
| Tenure | −0.001*** | −0.001*** | −0.001*** | −0.001*** | −0.001*** | −0.001*** | −0.001*** | −0.001*** | −0.001*** | −0.018*** |
| | (0.001) | (0.001) | (0.000) | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) | (0.000) | |
| Constant | −0.365*** | −0.347*** | −0.328*** | −0.352*** | −0.331*** | −0.315*** | −0.365*** | −0.347*** | −0.329*** | – |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,416 | 15,348 | 16,360 | 14,329 | 15,348 | 16,360 | 14,329 | 15,348 | 16,360 | 15,348 |
| Adjusted $R^2$ | 0.060 | 0.062 | 0.065 | 0.059 | 0.061 | 0.064 | 0.060 | 0.062 | 0.065 | 0.062 |

This table reports the results from the tobit regression models estimating the number of environmental lawsuits filed in year t. The key explanatory variables, *female* and *femceo*, are lagged by one, two, and three years in turn. Column (10) presents the standardized coefficients from re-estimating Model (8) using an OLS regression model. All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

### *4.3. Baseline regression analysis*

Table 4 reports the results of the tobit regressions estimating the number of environmental lawsuits filed against a firm in year t, employing industry- and year-fixed effects.[4] I run three sets of regressions. Models (1)–(3) employ board gender diversity (*female*) as the test variable. Models (4)–(6) employ CEO gender (*femceo*), and Models (7)–(9) include both board and CEO gender diversity. The coefficient of *female* (lagged t-3, t-2, and t-1) is negative and significant ($p < 0.01$) in Models (1), (2), and (3). This indicates that firms with greater female board representation experience significantly fewer environmental lawsuits. CEO gender (*femceo*) is not significantly associated with environmental litigation in Models (4)–(6). Finally, in Models (7)–(9), the coefficient of *female* remains negative and significant ($p < 0.01$), whereas the coefficient of *femceo* remains insignificant.

The estimated coefficients of *female* are both statistically and economically significant. Taking Model (8) as an example, the coefficient of $female_{(t-2)}$ is −0.132. This means every additional female director in year t-2 (based on the mean board size of 9 directors in the sample) is associated with 0.015 lower lawsuit frequency per year. Given the finding by Karpoff et al. (2005) that the

[4] As a robustness test, I re-run Eq. (1) using OLS regression models with industry-clustered standard errors. In untabulated results, the economic magnitude and statistical significance of the key variables remain consistent with those reported in Table 4.

cost of an average environmental lawsuit is approximately 2.26% of the sued firm's market value, this decrease in environmental lawsuits is equivalent to a saving of $3.1 million in firm value per year (based on the mean market capitalization of $9.041 billion in the sample). Further, I calculate the standardized coefficients by re-estimating the regression in Model (8) using an OLS model. Standardized coefficients allow comparisons of the relative importance of the independent variables within a regression model. As reported in Column (10), the standardized coefficient of $female_{(t\text{-}2)}$ is −0.033, which is the third largest in absolute value among all independent variables, ranked below only firm size (*logTA*) and board independence (*boardindep*) (with standardized coefficients of 0.206 and 0.034, respectively). These results are not surprising, because larger firms are more frequently sued (McTier and Wald, 2011) and tend to have more independent boards (Knyazeva et al., 2013). The ranking of these standardized coefficients provides evidence that, apart from firm size and board independence, board gender diversity is the next most potent factor in predicting environmental lawsuit frequency.

Consistent with H1, I find evidence that greater female board representation is associated with a lower incidence of environmental misconduct as proxied by lawsuits. However, there is no evidence to support H2 that CEO gender is significant in predicting lawsuit frequency. The link between board gender diversity and reduced environmental wrongdoing can be explained by several theoretical avenues. First, gender socialization theory suggests that women, through early socialization, develop the "ethics of caring" and are more conscious of the interests of third-parties (Gilligan, 1977; Eagly and Crowley, 1986; Bear et al., 2010; Adams et al., 2011; Cumming et al., 2015). Corporate policies founded upon consideration of stakeholder and societal interests are more likely to avoid environmental violations that harm local communities and unrelated third-parties. These results are also consistent with prior findings that board gender diversity reduces unethical conduct such as securities violations (Cumming et al., 2015; García Lara et al., 2017). Second, the presence of female directors can enhance group decision-making and governance quality by bringing different perspectives and a widened array of strategies and solutions (Erhardt et al., 2003; Westphal and Bednar, 2005; Cumming et al., 2015; Estélyi and Nisar, 2016). Third, this finding is consistent with the expectation that women directors are less overconfident and more willing to seek expert advice (e.g., Levi et al., 2014; Cumming et al., 2015), both of which can contribute to reducing corporate environmental exposure.

### 4.4. *Corporate environmental policies as a mechanism to reduce lawsuits*

To further corroborate the baseline findings, I explore one mechanism through which board gender diversity can reduce environmental litigation, specifically by influencing corporate environmental policies. Board leadership can affect corporate conduct through multiple mechanisms, including (1) setting official firm policies, or (2) through the more subtle means of influencing corporate culture and employee attitudes (e.g., Biggerstaff et al., 2015; Liu, 2016).[5] The second mechanism is difficult to observe. However, the first mechanism can be examined by using environmental CSR ratings as an empirical proxy for firm environmental policies. In this section, I use Kinder Lydenberg Domini (KLD) ratings to investigate the relationship between board gender diversity and firm environmental policies. If H1 is true in that gender-diverse boards can influence corporate policies to reduce environmental lawsuits, then gender diversity should be associated with superior environmental ratings. Accordingly, I re-run Eqs. (1) and (2) using OLS regression models to predict three alternative measures of environmental policies in turn, as reported in Table 5. First, Models (1)–(3) predict *env_ratings*, which represents a firm's overall KLD environmental rating in year t, calculated as the aggregated number of environmental strengths minus environmental concerns. Second, Models (4)–(6) predict *env_strengths*, which captures the number of positive environmental initiatives (or "strengths"). Finally, Models (7)–(9) predict *env_concerns*, which captures the number of environmental concerns of each firm-year.

Consistent with expectations, the results in Table 5 show that the coefficient of *female* (lagged t-1, t-2, and t-3) is positive in predicting *env_ratings* and *env_strengths* in Models (1)–(6) ($p < 0.01$), and negative in predicting *env_concerns* in Models (7)–(9) ($p < 0.01$). These results indicate that board gender diversity is significantly associated with improved overall environmental ratings, greater environmental strengths, and fewer environmental concerns, all of which may lead to a reduction in environmental lawsuits. The magnitude of the coefficient of $female_{(t\text{-}2)}$ in Model (2) is 0.887, indicating that every additional female director on the board is associated with an increase of 0.1 in environmental ratings (based on the mean board size of 9 directors in the sample). In Column (10), I report the standardized coefficients from Model (2), which provide insights into the relative importance of the independent variables in predicting the dependent variable. The standardized coefficient of *female* (0.084) is ranked third in magnitude among all independent variables, meaning that female board representation is highly important in predicting environmental ratings, second only to market-to-book ratio (0.121) and leverage (−0.088). Further, *female* is ranked ahead of other significant firm characteristics including board independence (−0.051), firm size (0.030), and institutional block-holdings (0.029). These results indicate that board gender diversity is both statistically and economically significant in predicting firms' environmental policies as captured by KLD ratings.

[5] It is possible for management to have contradictory influences over a firm's official policies and underlying culture. For example, before BP's oil spill in 2010, BP had formulated extensive environmental policies that created a "symbolic bubble" of eco-friendly rhetoric (Matejek and Gössling, 2014, p. 575). At the same time, there was an underlying culture of neglect in the company concerning environmental safety that preceded the explosion at the Deepwater Horizon oil rig (Lustgarten and Knutson, 2010; Neill and Morris, 2012). Therefore, environmental policies *per se* do not fully capture a firm's actual environmental (mis)conduct. In this study, I use environmental lawsuits as a more accurate proxy for substantive corporate actions involving environmental violations. However, examining environmental policies allows me to explore one potential mechanism through which board gender diversity can influence corporate policies to reduce environmental lawsuits.

**Table 5**
Board gender diversity and environmental policies.

| | KLD environmental ratings | | | KLD environmental strengths | | | KLD environmental concerns | | | Standardized coefficients |
|---|---|---|---|---|---|---|---|---|---|---|
| | Env_ratings (1) | Env_ratings (2) | Env_ratings (3) | Env_strengths (4) | Env_strengths (5) | Env_strengths (6) | Env_concerns (7) | Env_concerns (8) | Env_concerns (9) | Model (2) (10) |
| $Female_{(t-3)}$ | 0.955*** | | | 0.498*** | | | −0.457*** | | | |
| | (0.000) | | | (0.000) | | | (0.000) | | | |
| $Female_{(t-2)}$ | | 0.887*** | | | 0.427*** | | | −0.460*** | | 0.084*** |
| | | (0.000) | | | (0.000) | | | (0.000) | | |
| $Female_{(t-1)}$ | | | 0.897*** | | | 0.431*** | | | −0.465*** | |
| | | | (0.000) | | | (0.000) | | | (0.000) | |
| LogTA | 0.017 | 0.020* | 0.021** | 0.227*** | 0.224*** | 0.219*** | 0.210*** | 0.204*** | 0.198*** | 0.030* |
| | (0.139) | (0.074) | (0.047) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| ROA | 0.062 | 0.053 | 0.051 | 0.410*** | 0.357*** | 0.337*** | 0.348*** | 0.304*** | 0.286*** | 0.005 |
| | (0.568) | (0.599) | (0.593) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| Leverage | −0.037*** | −0.037*** | −0.039*** | −0.006 | −0.006 | −0.006 | 0.031*** | 0.031*** | 0.032*** | −0.088*** |
| | (0.000) | (0.000) | (0.000) | (0.277) | (0.277) | (0.192) | (0.000) | (0.000) | (0.000) | |
| Marketbook | 0.040*** | 0.039*** | 0.040*** | 0.013** | 0.013** | 0.013*** | −0.027*** | −0.027*** | −0.027*** | 0.121*** |
| | (0.000) | (0.000) | (0.000) | (0.014) | (0.014) | (0.007) | (0.000) | (0.000) | (0.000) | |
| Cash | 0.121* | 0.074 | 0.030 | 0.033 | 0.016 | −0.001 | −0.088* | −0.059 | −0.031 | 0.009 |
| | (0.085) | (0.236) | (0.597) | (0.569) | (0.763) | (0.992) | (0.055) | (0.157) | (0.422) | |
| TobinQ | −0.005** | −0.004* | −0.003 | 0.002 | 0.003 | 0.003** | 0.006*** | 0.006*** | 0.006*** | −0.018* |
| | (0.037) | (0.053) | (0.119) | (0.414) | (0.152) | (0.037) | (0.000) | (0.000) | (0.000) | |
| AltmanZ | 0.004 | −0.000 | −0.007 | −0.009 | −0.008 | −0.007 | −0.013 | −0.007 | −0.001 | 0.000 |
| | (0.784) | (0.981) | (0.584) | (0.458) | (0.500) | (0.477) | (0.177) | (0.412) | (0.944) | |
| Boardsize | −0.002 | −0.003 | −0.003 | 0.015*** | 0.016*** | 0.016*** | 0.018*** | 0.019*** | 0.019*** | −0.007 |
| | (0.667) | (0.568) | (0.497) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| Boardindep | −0.368*** | −0.348*** | −0.329*** | 0.215*** | 0.226*** | 0.228*** | 0.583*** | 0.574*** | 0.557*** | −0.051*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| Blockhold | 0.145** | 0.146** | 0.148*** | −0.066 | −0.063 | −0.064 | −0.210*** | −0.209*** | −0.212*** | 0.029** |
| | (0.016) | (0.013) | (0.009) | (0.124) | (0.134) | (0.118) | (0.000) | (0.000) | (0.000) | |
| Tenure | 0.000 | 0.000 | 0.001 | −0.002*** | −0.002*** | −0.002*** | −0.003*** | −0.003*** | −0.003*** | 0.002 |
| | (0.715) | (0.754) | (0.603) | (0.005) | (0.006) | (0.008) | (0.000) | (0.001) | (0.000) | |
| Constant | −0.857*** | −0.833*** | −0.799*** | −2.032*** | −2.021*** | −1.982*** | −1.175*** | −1.188*** | −1.183*** | – |
| | (0.002) | (0.001) | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 9211 | 9767 | 10,372 | 9211 | 9767 | 10,372 | 9211 | 9767 | 10,372 | 9767 |
| Adjusted $R^2$ | 0.147 | 0.143 | 0.141 | 0.315 | 0.312 | 0.310 | 0.304 | 0.301 | 0.298 | 0.143 |

This table reports the results from the OLS regression models estimating the environmental CSR ratings in year t as recorded by Kinder Lydenberg Domini (KLD), specifically the overall environmental ratings, the number of environmental strengths, and the number of environmental concerns. The key explanatory variable, *female*, is lagged by one, two, and three years in turn. Column (10) presents the standardized coefficients from Model (2). All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

This evidence provides further support for H1 by demonstrating one mechanism through which board gender diversity can be linked to fewer environmental lawsuits, namely through influencing firms' environmental policies to increase the number of environmental strengths and reduce the number of environmental concerns.

### 4.5. Complementary roles of board gender diversity and CEO gender

In this section, I run additional subsample analyses to explore the interplay between board gender diversity and CEO gender. Under H1 and H2, three potential mechanisms link female corporate leadership to environmental misconduct: (i) gender-based ethical values (such as universalism and benevolence), (ii) greater diversity enhancing group decision-making, and (iii) reduced overconfidence. If these mechanisms explain the link between corporate gender diversity and firm policies, then we should expect female CEOs and female directors to serve complementary roles in the boardroom. In particular, if the presence of women (i) enhances ethical considerations (e.g., to prevent harm to others under universalistic value) and (ii) introduces a broader range of perspectives into board decision-making, then having *either* female CEOs *or* female directors should bring about these improvements. In other words, the impact of having a female CEO should be stronger if there are no (or few) other women on the board. Conversely, if the presence of female directors curbs the overconfidence of male CEOs in formulating corporate strategies, as documented in the context of investment and acquisition decisions (Chen et al., 2016a; Chen et al., 2017; Banerjee et al., 2018), then the role of female directors should be less pronounced if the CEO is also female (and hence less likely to be overconfident).

To test these propositions, I first split the sample into two subsamples with high versus low board gender diversity, based on whether the lagged proportion of female directors ($female_{(t\text{-}1)}$) is above/equal or below the sample median. Within each subsample, I re-run Eq. (2) using CEO gender (*femceo*) to predict environmental litigation. The results are reported in Panel A of Table 6, where Models (1)–(3) present the results using the subsample with high board gender diversity, and Models (4)–(6) present the results using the subsample with low board gender diversity. In the second set of analyses, I divide the sample by CEO gender ($femceo_{(t\text{-}1)}$) and re-run Eq. (1) using the two subsamples with male versus female CEOs. The results are reported in Models (1)–(3) and Models (4)–(6), Panel B.

As reported in Models (1)–(3), Panel A, within the subsample with high board gender diversity, the presence of a female CEO (*femceo*) is not significantly associated with environmental lawsuit frequency. This is consistent with the baseline results in Table 4. However, within the subsample with *low* board gender diversity, the coefficient of *femceo* is negative and significant in predicting *env* ($p < 0.01$) in Models (4)–(6). The estimated coefficient of $femceo_{(t\text{-}2)}$ is $-0.148$ in Model (5), indicating that having a female CEO is associated with 0.148 fewer lawsuits per year (which is three times larger than the mean lawsuit frequency of 0.049 per firm-year in the sample).

These results provide conditional support for H2 by demonstrating that female CEOs are associated with reduced frequency of environmental litigation, but this relationship is significant *only* when the firms have low female representation on their boards. This evidence shows that CEO gender and board gender diversity play complementary roles in corporate decision-making, consistent with the ethicality and diversity explanations of H1 and H2. Specifically, as shown by Adams and Funk (2012), female corporate leaders exhibit different ethical values from their male counterparts, including universalism and benevolence. These ethical traits are relevant in formulating environmental policies, since violations of environmental law often harm community members who have little recourse to punish the offending firms (Karpoff et al., 2005). If women's participation can introduce these ethical considerations into corporate decision-making, then this should be achieved by having either female CEOs or female directors. Consequently, on a board with lower gender diversity, the role of a female CEO is more pronounced.

I next explore the role of board gender diversity in the presence of male versus female CEOs. As reported in Models (1)–(3), Panel B, using the subsample with female CEOs, there is weak evidence that board gender diversity is associated with fewer environmental lawsuits. The estimated coefficients of $female_{(t\text{-}3)}$ and $female_{(t\text{-}2)}$ are significant in Models (2) and (3) ($p < 0.10$). In contrast, using the male-CEO subsample, there is strong evidence that female board representation is associated with reduced lawsuits. The coefficient of *female* (lagged t-1, t-2, and t-3) is uniformly negative and significant ($p < 0.01$) in Models (4)–(6). Prior evidence shows that board gender diversity plays an important role in mitigating the overconfidence of male CEOs when making investment and acquisition decisions (Chen et al., 2016a; Chen et al., 2017; Banerjee et al., 2018). The results from this subsample analysis concur with these prior findings. They show that female board representation serves a more potent role in reducing environmental lawsuits in firms that have male CEOs compared with firms with female CEOs.

Overall, these subsample analyses provide novel and important insights into the complementary roles of board gender diversity and CEO gender. Consistent with expectations, female CEOs play an important part in reducing environmental lawsuits in firms with low female board representation and, conversely, board gender diversity serves a more pronounced role in firms led by male CEOs.

### 4.6. Robustness analyses

To ensure the robustness of the baseline results, in this section I conduct a series of additional analyses, including the use of different subsamples, alternative variable definitions and model specifications, industry adjustments, a propensity score matching approach, and replication of prior research.

#### 4.6.1. Critical mass theory

According to critical mass theory, one or two women on the board may serve only a token role and have limited opportunities to make real impacts on corporate decision-making, because they are outnumbered by male directors (Westphal and Milton, 2000;

**Table 6**
Subsample analyses.

Panel A: CEO gender and environmental lawsuits

| | High board gender diversity subsample | | | Low board gender diversity subsample | | |
|---|---|---|---|---|---|---|
| | Env<br>(1) | Env<br>(2) | Env<br>(3) | Env<br>(4) | Env<br>(5) | Env<br>(6) |
| $Femceo_{(t-3)}$ | −0.005<br>(0.646) | | | −0.121***<br>(0.010) | | |
| $Femceo_{(t-2)}$ | | −0.002<br>(0.861) | | | −0.148***<br>(0.000) | |
| $Femceo_{(t-1)}$ | | | 0.003<br>(0.822) | | | −0.125***<br>(0.002) |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 7977 | 8721 | 9576 | 6352 | 6627 | 6784 |
| Adjusted $R^2$ | 0.069 | 0.070 | 0.064 | 0.062 | 0.064 | 0.082 |

Panel B: Board gender diversity and environmental lawsuits

| | Female CEO subsample | | | Male CEO subsample | | |
|---|---|---|---|---|---|---|
| | Env<br>(1) | Env<br>(2) | Env<br>(3) | Env<br>(4) | Env<br>(5) | Env<br>(6) |
| $Female_{(t-3)}$ | −0.159*<br>(0.054) | | | −0.123***<br>(0.001) | | |
| $Female_{(t-2)}$ | | −0.144*<br>(0.054) | | | −0.134***<br>(0.000) | |
| $Female_{(t-1)}$ | | | −0.189<br>(0.118) | | | −0.113***<br>(0.000) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 306 | 368 | 439 | 14,023 | 14,980 | 15,921 |
| Adjusted $R^2$ | −0.183 | −0.308 | 3.517 | 0.059 | 0.061 | 0.063 |

Panel A reports the tobit regression models estimating the number of environmental lawsuits filed in year t using two subsamples with high versus low board gender diversity (by a median-split using $female_{(t-1)}$). Panel B reports the results from the tobit regression models estimating the number of environmental lawsuits filed in year t using two subsamples with female versus male CEOs (based on the value of $femceo_{(t-1)}$). All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

**Table 7**
Gender critical mass.

| | Board gender diversity | | | Board and CEO gender diversity | | |
|---|---|---|---|---|---|---|
| | Env<br>(1) | Env<br>(2) | Env<br>(3) | Env<br>(4) | Env<br>(5) | Env<br>(6) |
| $Female3_{(t-3)}$ | −0.032**<br>(0.048) | | | −0.032*<br>(0.055) | | |
| $Female3_{(t-2)}$ | | −0.045***<br>(0.000) | | | −0.046***<br>(0.000) | |
| $Female3_{(t-1)}$ | | | −0.039***<br>(0.001) | | | −0.039***<br>(0.001) |
| $Femceo_{(t-3)}$ | | | | −0.003<br>(0.798) | | |
| $Femceo_{(t-2)}$ | | | | | 0.003<br>(0.796) | |
| $Femceo_{(t-1)}$ | | | | | | 0.007<br>(0.580) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,416 | 15,348 | 16,360 | 14,329 | 15,348 | 16,360 |
| Adjusted $R^2$ | 0.059 | 0.062 | 0.065 | 0.059 | 0.062 | 0.065 |

This table reports the results from the tobit regression models estimating the number of environmental lawsuits filed in year t. The key explanatory variable, *female3*, is a binary variable that equals one if there are three or more female directors on the board (lagged by one, two, and three years in turn). All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Konrad et al., 2008). The number of women on a corporate board must exceed a certain threshold before their opinions can significantly influence corporate policies (Post et al., 2011; Jia and Zhang, 2013). Empirical evidence indicates that three or more directors constitute such a critical mass (Post et al., 2011; Torchia et al., 2011; Joecks et al., 2013; Liu et al., 2014). Following Post et al. (2011) and Jia and Zhang (2013), I re-estimate the baseline regressions in Eq. (1) by employing a new binary test variable, *female3*, which equals one if three or more female directors are on the board and zero otherwise.

In Models (1)–(3), Table 7, the coefficient of *female3* (lagged t-3, t-2, and t-1) is consistently negative and significant in predicting the number of environmental lawsuits ($p < 0.05$ in Model (1) and $p < 0.01$ in Models (2)–(3)). After adding CEO gender (*femceo*) as an additional explanatory variable, the coefficient of *female3* remains negative and significant ($p < 0.10$ in Model (4) and $p < 0.01$ in Models (5)–(6)). These results support the critical mass theory by indicating that firms with three or more women on the board experience significantly fewer environmental lawsuits. These results further corroborate the key findings that board gender diversity is significantly and negatively associated with corporate environmental litigation.

*4.6.2. The glass cliff phenomenon*

Women are often appointed into precarious leadership positions that are associated with increased risk of criticism, failure, or crisis (Ryan and Haslam, 2005; Haslam and Ryan, 2008; Mulcahy and Linehan, 2014). Both archival and experimental evidence shows that female CEOs are more likely to be selected when firms are experiencing problems, such as poor financial performance (Ryan and Haslam, 2007; Adams et al., 2009). This “glass cliff” phenomenon is partly attributable to the superior perceived abilities of women to lead troubled firms (Haslam and Ryan, 2008; Visser, 2011), but it nonetheless constitutes a gender-based barrier preventing women from succeeding in corporate leadership (Adams et al., 2009; Bruckmüller et al., 2013; Mulcahy and Linehan, 2014). Under the glass cliff hypothesis, firms facing imminent environmental lawsuits may be motivated to appoint female CEOs, not to better manage environmental exposure *ex ante* to prevent litigation, but to defend the firms *ex post* against impending allegations inherited from their predecessors. In these scenarios, appointing a female CEO is not expected to reduce the frequency of environmental lawsuits.

I control for the potential effect of the glass cliff phenomenon to ensure the robustness of the findings of this study. In addition to including CEO tenure as a control variable in the baseline regressions, I conduct the following subsample analyses. First, I exclude from the sample those firm-years where CEO tenure is less than one year at the time of the lawsuit filing, and re-run the models in Eq. (1) and (2) (the results are reported in Panel A, Table 8). In addition, I split the sample into two groups based on whether CEO tenure at the time of the lawsuit is above/equal to three years or below three years. I re-estimate the baseline regressions using each subsample (the results are reported in Panel B, Table 8).

As reported in Panel A, after excluding those firm-year observations with “last-minute” CEO appointments (where tenure is less than one year), the results relating to the key independent variables remain substantively unchanged from the baseline results in Table 4. The coefficient of *female* remains negative and significant ($p < 0.01$) in Models (1)–(3) and (7)–(9), with similar magnitudes as those reported in Table 4, and *femceo* remains insignificant in Models (4)–(9). In Panel B, Table 8, Models (1)–(6) report the results from the re-estimated regressions using the subsample with long CEO tenure (three years or more), and Models (7)–(12) report the regression results using the short-tenure subsample (less than three years). The *female* coefficient remains negative and significant

**Table 8**
CEO tenure and the glass cliff phenomenon.

Panel A: Excluding observations with CEO tenure of less than one year

| | Board gender diversity | | | CEO gender | | | Board and CEO gender diversity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Env (1) | Env (2) | Env (3) | Env (4) | Env (5) | Env (6) | Env (7) | Env (8) | Env (9) |
| $Female_{(t-3)}$ | −0.117*** (0.001) | | | | | | −0.117*** (0.001) | | |
| $Female_{(t-2)}$ | | −0.125*** (0.000) | | | | | | −0.129*** (0.000) | |
| $Female_{(t-1)}$ | | | −0.107*** (0.000) | | | | | | −0.112*** (0.000) |
| $Femceo_{(t-3)}$ | | | | −0.011 (0.319) | | | 0.005 (0.709) | | |
| $Femceo_{(t-2)}$ | | | | | −0.009 (0.406) | | | 0.008 (0.491) | |
| $Femceo_{(t-1)}$ | | | | | | −0.004 (0.764) | | | 0.011 (0.372) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,402 | 15,332 | 16,340 | 14,315 | 15,332 | 16,340 | 14,315 | 15,332 | 16,340 |
| Adjusted $R^2$ | 0.059 | 0.061 | 0.064 | 0.058 | 0.060 | 0.063 | 0.059 | 0.061 | 0.064 |

Panel B: Subsample analysis based on duration of CEO tenure

| | Long tenure subsample (tenure ≥ 3 years) | | | | | | Short tenure subsample (tenure < 3 years) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Board gender diversity | | | Board and CEO gender diversity | | | Board gender diversity | | | Board and CEO gender diversity | | |
| | Env (1) | Env (2) | Env (3) | Env (4) | Env (5) | Env (6) | Env (7) | Env (8) | Env (9) | Env (10) | Env (11) | Env (12) |
| $Female_{(t-3)}$ | −0.103*** (0.006) | | | −0.106*** (0.007) | | | −0.163** (0.036) | | | −0.153* (0.065) | | |
| $Female_{(t-2)}$ | | −0.105*** (0.004) | | | −0.110*** (0.004) | | | −0.189*** (0.002) | | | −0.188*** (0.004) | |
| $Female_{(t-1)}$ | | | −0.083*** (0.009) | | | −0.084** (0.011) | | | −0.199*** (0.001) | | | −0.220*** (0.001) |
| $Femceo_{(t-3)}$ | | | | 0.008 (0.576) | | | | | | −0.012 (0.614) | | |
| $Femceo_{(t-2)}$ | | | | | 0.010 (0.454) | | | | | | −0.002 (0.898) | |
| $Femceo_{(t-1)}$ | | | | | | 0.002 (0.849) | | | | | | 0.047 (0.258) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

(*continued on next page*)

**Table 8** (*continued*)

Panel B: Subsample analysis based on duration of CEO tenure

| | Long tenure subsample (tenure ≥ 3 years) | | | | | | Short tenure subsample (tenure < 3 years) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Board gender diversity | | | Board and CEO gender diversity | | | Board gender diversity | | | Board and CEO gender diversity | | |
| | Env<br>(1) | Env<br>(2) | Env<br>(3) | Env<br>(4) | Env<br>(5) | Env<br>(6) | Env<br>(7) | Env<br>(8) | Env<br>(9) | Env<br>(10) | Env<br>(11) | Env<br>(12) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 11,708 | 12,490 | 13,345 | 11,636 | 12,490 | 13,345 | 2788 | 2946 | 3106 | 2772 | 2946 | 3106 |
| pseudo $R^2$ | 0.063 | 0.066 | 0.069 | 0.063 | 0.066 | 0.069 | 0.055 | 0.058 | 0.059 | 0.057 | 0.058 | 0.059 |

Panel A reports the results from the tobit regression models estimating the number of environmental lawsuits filed in year t, after excluding from the sample those firm-year observations with CEO tenure of less than one year. Panel B reports the results from the tobit regression models estimating the number of environmental lawsuits filed in year t, using two subsamples with long CEO tenure (of three years or more) versus short CEO tenure (of less than three years). All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

across both subsamples ($p < 0.05$ or better, except for Model (10) where $p < 0.10$). These results demonstrate the robustness of the results in Table 4 after accounting for the potential impacts of the glass cliff phenomenon.

#### 4.6.3. Female independent directors

Female independent directors and executive directors may affect corporate policies in different ways (Liu et al., 2014). In this section, I re-examine board gender diversity by focusing only on female independent directors. The explanatory variable, *femindep*, is calculated as the proportion of female independent directors scaled by total board size (lagged t-1, t-2, and t-3).[6] In addition, in accordance with the critical mass theory, I employ an alternative binary explanatory variable, *femindep3*, which equals one if there are three or more female *independent* directors on the board, and zero otherwise (Post et al., 2011; Torchia et al., 2011; Joecks et al., 2013; Liu et al., 2014). I re-run Eq. (1) using *femindep* (and *femindep3*) as alternative key explanatory variables in lieu of *female*. As reported in Table 9, the coefficients of both *femindep* and *femindep3* are consistently negative and significant in Models (1)–(12) ($p < 0.05$ or better). The economic magnitude of the *femindep* coefficient is similar to but slightly larger than that reported in Table 4 (e.g., the coefficient of $femindep_{(t-2)}$ is −0.137 in Model (2) compared with −0.128 in Model (2), Table 4). Apart from confirming the validity of the baseline findings, these results also indicate that the observed relationship between board gender diversity and environmental lawsuits is mainly driven by the presence of female independent rather than executive directors.

#### 4.6.4. Industry-adjusted variables

To address the potential concern that both corporate gender diversity and environmental exposure are driven by industry variations, I include industry fixed effects in all regression models. In addition, I employ industry-adjusted dependent variables and key explanatory variables to re-estimate Eq. (1). The dependent variable, *env_adj*, measures the industry-adjusted frequency of environmental litigation, which equals the number of lawsuits filed in year t less the average number of environmental lawsuits within each one-digit SIC code industry, calculated by year. I also create an industry-adjusted board gender diversity variable, *female_adj*, by scaling the proportion of female directors by the industry mean within each one-digit SIC code industry, calculated by year. All variables are defined in Appendix A. The results are reported in Table 10.

Consistent with the baseline results in Table 4, the coefficient of $female\_adj_{(t-3)}$ remains negative and significant in predicting the industry-adjusted frequency of environmental lawsuits in Model (1), Table 10 ($p < 0.10$). Similarly, $female\_adj_{(t-2)}$ and $female\_adj_{(t-1)}$ are negatively and significantly associated with *env_adj* in Models (2)–(3) ($p < 0.05$). The coefficient of *femceo_adj* remains insignificant in Models (4)–(6). Further, as reported in Models (7)–(9), the inclusion of *femceo_adj* as an additional variable does not materially change the statistical significance or economic magnitude of the coefficients of *female_adj*. These results further confirm the robustness of the baseline results.

#### 4.6.5. Alternative industry controls and subsample analysis

In addition, to further alleviate the concern that the baseline findings might be solely driven by industry variations, I conduct the following analyses. First, I re-estimate Eqs. (1)–(2) by including two-digit SIC codes in the regressions in lieu of one-digit SIC codes. As reported in Panel A, Table 11, the estimated coefficients and statistical significance of the key explanatory variables remain substantively similar to those reported in Table 4. Furthermore, as reported in Table 2 (industry breakdown), since the Manufacturing industry (SIC = 4) accounts for approximately 49.5% of the observations in the dataset and experiences high litigation frequency, I conduct an industry-based subsample analysis, by re-estimating the regressions (including industry fixed effects based on two-digit SIC codes) using a subsample of observations within the Manufacturing sector. As reported in Panel B, Table 11, the coefficient of *female* (lagged t-1 and t-2) remains negative and significant ($p < 0.05$) in Models (2)–(3) in predicting the number of environmental lawsuits.[7] These robustness results further corroborate the baseline findings reported in Table 4.

#### 4.6.6. Propensity score matching

Given the potential issues of endogeneity and self-selection, I use a propensity score matching approach to eliminate any unobserved factors that may simultaneously determine board gender diversity and corporate environmental misconduct. I pair-match firm-year observations from the subsamples with high versus low female board representation (with lagged $female_{(t-1)}$ above/equal or below the sample median) within each year by industry (using the one-digit SIC code) and other firm-level matching criteria, including firm size (total assets), performance (ROA), cash holdings, growth opportunity (market-to-book ratio), risk (leverage), board size, proportion of independent directors, block-holding, and CEO tenure (all lagged by one year). I then re-run the baseline regressions as specified in Eq. (1) using the propensity score-matched sample.

As reported in Models (1)–(3), Table 12, the estimated coefficient of the key explanatory variable, *female* (lagged t-3, t-2, and t-1),

[6] As an additional robustness test, I re-calculate *femindep* as the number of female independent directors divided by the number of *independent* directors on the board. In untabulated results, the estimated coefficients and statistical significance of the key explanatory variables are consistent with the results reported in Table 9.

[7] In addition, I repeat the industry-based subsample analyses for two other industries with high environmental litigation frequency, Mining and Oil (SIC = 2) and Transport, Communications, Electric and Gas (SIC = 5). In untabulated results, when the regressions are estimated using a subsample of firms in the Mining and Oil industry, board gender diversity is not significantly associated with reduced environmental lawsuits. On the other hand, using a subsample of firms in the industry of Transport, Communications, Electric and Gas, the unabulated regression results show that the coefficient of *female* (lagged t-1, t-2, and t-3) remains negative and significant ($p < 0.01$), indicating that board gender diversity is associated with fewer environmental lawsuits in that industry.

**Table 9**
Independent female directors.

| | Board gender diversity | | | | | | Board and CEO gender diversity | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Independent directors | | | Independent directors: critical mass | | | Independent directors | | | Independent directors: critical mass | | |
| | Env (1) | Env (2) | Env (3) | Env (4) | Env (5) | Env (6) | Env (7) | Env (8) | Env (9) | Env (10) | Env (11) | Env (12) |
| $Femindep_{(t-3)}$ | −0.125*** (0.001) | | | | | | −0.123*** (0.001) | | | | | |
| $Femindep_{(t-2)}$ | | −0.137*** (0.000) | | | | | | −0.136*** (0.000) | | | | |
| $Femindep_{(t-1)}$ | | | −0.125*** (0.000) | | | | | | −0.125*** (0.000) | | | |
| $Femindep3_{(t-3)}$ | | | | −0.041** (0.013) | | | | | | −0.041** (0.014) | | |
| $Femindep3_{(t-2)}$ | | | | | −0.054*** (0.000) | | | | | | −0.054*** (0.000) | |
| $Femindep3_{(t-1)}$ | | | | | | −0.054*** (0.000) | | | | | | −0.054*** (0.000) |
| $Femceo_{(t-3)}$ | | | | | | | −0.009 (0.425) | | | −0.009 (0.430) | | |
| $Femceo_{(t-2)}$ | | | | | | | | −0.007 (0.518) | | | −0.007 (0.553) | |
| $Femceo_{(t-1)}$ | | | | | | | | | −0.002 (0.866) | | | −0.001 (0.934) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *N* | 14,416 | 15,348 | 16,360 | 14,416 | 15,348 | 16,360 | 14,329 | 15,348 | 16,360 | 14,329 | 15,348 | 16,360 |
| pseudo $R^2$ | 0.060 | 0.062 | 0.065 | 0.059 | 0.062 | 0.065 | 0.060 | 0.062 | 0.065 | 0.060 | 0.062 | 0.065 |

This table reports the results from the tobit regression models estimating the number of environmental lawsuits filed in year t. The key explanatory variables, *femindep* (*femindep3*), capture the proportion (critical-mass number) of female independent directors on the board (lagged by one, two, and three years in turn). All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

**Table 10**
Industry-adjusted gender diversity and environmental lawsuits.

| | Board gender diversity | | | CEO gender | | | Board and CEO gender diversity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Env_adj (1) | Env_adj (2) | Env_adj (3) | Env_adj (4) | Env_adj (5) | Env_adj (6) | Env_adj (7) | Env_adj (8) | Env_adj (9) |
| $Female\_adj_{(t-3)}$ | −0.007* (0.052) | | | | | | −0.007* (0.079) | | |
| $Female\_adj_{(t-2)}$ | | −0.009** (0.011) | | | | | | −0.009** (0.015) | |
| $Female\_adj_{(t-1)}$ | | | −0.007** (0.013) | | | | | | −0.008** (0.016) |
| $Femceo\_adj_{(t-3)}$ | | | | −0.013 (0.260) | | | −0.005 (0.718) | | |
| $Femceo\_adj_{(t-2)}$ | | | | | −0.011 (0.326) | | | −0.000 (0.969) | |
| $Femceo\_adj_{(t-1)}$ | | | | | | −0.005 (0.652) | | | 0.004 (0.768) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,413 | 15,345 | 16,357 | 14,329 | 15,348 | 16,360 | 14,326 | 15,345 | 16,357 |
| Adjusted $R^2$ | 0.050 | 0.052 | 0.054 | 0.050 | 0.051 | 0.053 | 0.050 | 0.052 | 0.054 |

This table reports the results from the tobit regression models estimating the industry-adjusted number of environmental lawsuits filed in year t. The key explanatory variables, *female_adj* and *femceo_adj*, are adjusted by the industry mean (by year) within each one-digit SIC code industry. All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

remains statistically and economically significant ($p < 0.05$). For example, the coefficient of $female_{(t-2)}$ in Model (2) is −0.079, compared with −0.128 from the baseline regression in Table 4. This indicates that every additional female director on the board in year t-2 is associated with a reduction of 0.01 in lawsuit frequency (assuming an average-sized board of 9 directors), which is equivalent to a $2-million saving of lawsuit-induced loss of firm value per year, based on the sample mean market capitalization of $9.041 billion.[8] Further, after adding CEO gender as an additional variable in Models (7)–(9), the coefficient of *female* remains negative and significant with similar economic magnitude ($p < 0.05$). These results from the propensity score matching analysis show that the results reported in Table 4 are not driven by endogeneity or self-selection, and thus corroborate the findings of this study.

#### 4.6.7. Alternative model specifications

I employ alternative model specifications to further confirm the robustness of the findings. First, I employ Poisson regressions in lieu of tobit regressions to predict the number of environmental lawsuits, *env*. In untabulated results, the estimated coefficient of *female* (lagged t-1, t-2, and t-3) remains statistically and economically significant in predicting environmental lawsuits in all models ($p < 0.05$ or better). For example, the coefficient of $female_{(t-2)}$ is −2.262, indicating that a one-unit increase in the proportion of female board representation is associated with a decrease of 2.262 lawsuits. In other words, each additional female director is associated with approximately 0.25 fewer lawsuits (based on the mean board size of 9 directors in the sample). Second, I re-estimate the regressions using a logit model to predict a binary dependent variable, *envd*, which equals one if one or more environmental lawsuit(s) is/are filed against the firm in year t and zero otherwise. In untabulated results, the coefficient of *female* (lagged t-3, t-2, and t-1) remains consistently negative and significant in predicting the likelihood of environmental litigation ($p < 0.10$ or better). These results using alternative model specifications further confirm the robustness of the baseline results in support of H1.

#### 4.6.8. Replication of prior research with securities violations

Finally, to further demonstrate the soundness of the methodology employed in this study, I conduct an additional analysis using a different type of corporate lawsuit to replicate the results of prior research. Cumming et al. (2015) find that firms with gender-diverse boards are less likely to be accused of securities fraud. I replicate those findings using data from the Accounting and Auditing Enforcement Releases (AAER) Database which records Securities and Exchange Commission (SEC) investigations of accounting and auditing misconduct (Dechow et al., 2011). I compute a binary dependent variable, *securities*, which equals one if there is an AAER investigation against a firm in a given year, and zero otherwise. I run logit regressions with industry and year dummies to predict *securities* in lieu of *env* as the dependent variable. In untabulated results, the coefficient of the key explanatory variable *female* (lagged t-3, t-2, and t-1) is negative and significant in predicting *securities* ($p < 0.01$), indicating that firms with greater female board representation are less likely to be accused of securities fraud. CEO gender (*femceo*) is not significantly associated with securities lawsuits. These results confirm prior findings that board gender diversity is associated with a reduced likelihood of securities fraud

[8] According to Karpoff et al. (2005), the loss of shareholder wealth associated with an average environmental lawsuit is approximately 2.26% of the sued firm's market capitalization.

**Table 11**
Alternative industry controls and subsample analysis.

Panel A: Alternative industry fixed effects using two-digit SIC codes.

| | Board gender diversity | | | Board and CEO gender diversity | | |
|---|---|---|---|---|---|---|
| | Env<br>(1) | Env<br>(2) | Env<br>(3) | Env<br>(4) | Env<br>(5) | Env<br>(6) |
| $Female_{(t-3)}$ | −0.095***<br>(0.009) | | | −0.096**<br>(0.012) | | |
| $Female_{(t-2)}$ | | −0.102***<br>(0.002) | | | −0.105***<br>(0.003) | |
| $Female_{(t-1)}$ | | | −0.084***<br>(0.004) | | | −0.089***<br>(0.004) |
| $Femceo_{(t-3)}$ | | | | 0.005<br>(0.699) | | |
| $Femceo_{(t-2)}$ | | | | | 0.007<br>(0.579) | |
| $Femceo_{(t-1)}$ | | | | | | 0.009<br>(0.468) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE $_{(SIC2)}$ | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 14,416 | 15,348 | 16,360 | 14,329 | 15,348 | 16,360 |
| Adjusted $R^2$ | 0.150 | 0.159 | 0.162 | 0.150 | 0.159 | 0.162 |

Panel B: Subsample analysis with manufacturing industry (SIC = 4).

| | Board gender diversity | | | Board and CEO gender diversity | | |
|---|---|---|---|---|---|---|
| | Env<br>(1) | Env<br>(2) | Env<br>(3) | Env<br>(4) | Env<br>(5) | Env<br>(6) |
| $Female_{(t-3)}$ | −0.090<br>(0.134) | | | −0.088<br>(0.163) | | |
| $Female_{(t-2)}$ | | −0.112**<br>(0.044) | | | −0.112*<br>(0.052) | |
| $Female_{(t-1)}$ | | | −0.102**<br>(0.028) | | | −0.099**<br>(0.039) |
| $Femceo_{(t-3)}$ | | | | −0.001<br>(0.974) | | |
| $Femceo_{(t-2)}$ | | | | | 0.000<br>(0.989) | |
| $Femceo_{(t-1)}$ | | | | | | −0.008<br>(0.715) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE $_{(SIC2)}$ | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 7231 | 7642 | 8105 | 7196 | 7642 | 8105 |
| Adjusted $R^2$ | 0.118 | 0.123 | 0.121 | 0.119 | 0.123 | 0.121 |

Panel A reports the results from the tobit regression models estimating the number of environmental lawsuits filed in year t by including two-digit SIC codes. Panel B reports the results from the tobit regression models (including two-digit SIC codes) estimated using a subsample of observations within the Manufacturing industry (SIC = 4). The key explanatory variables, *female* and *femceo*, are lagged by one, two, and three years in turn. All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

(Cumming et al., 2015). They further validate the robustness of the methodology employed and the findings documented in this study.

## 5. Discussion and conclusion

This study examines the relationship between board gender diversity, CEO gender, and corporate environmental misconduct as captured by lawsuits. I find that firms with greater female representation on their boards experience fewer environmental lawsuits. Female CEOs are significantly associated with reduced environmental litigation only in firms that have otherwise low female board representation. Additionally, in firms led by male CEOs, board gender diversity plays a more potent role in preventing environmental misconduct. The results are robust to a number of additional analyses, including subsample analyses, alternative model specifications

**Table 12**
Propensity score matching.

| | Board gender diversity | | | CEO gender | | | Board and CEO gender diversity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Env<br>(1) | Env<br>(2) | Env<br>(3) | Env<br>(4) | Env<br>(5) | Env<br>(6) | Env<br>(7) | Env<br>(8) | Env<br>(9) |
| $Female_{(t-3)}$ | −0.085** (0.030) | | | | | | −0.088** (0.033) | | |
| $Female_{(t-2)}$ | | −0.079** (0.046) | | | | | | −0.082** (0.048) | |
| $Female_{(t-1)}$ | | | −0.074** (0.049) | | | | | | −0.080** (0.044) |
| $Femceo_{(t-3)}$ | | | | −0.001 (0.932) | | | 0.011 (0.358) | | |
| $Femceo_{(t-2)}$ | | | | | −0.005 (0.648) | | | 0.007 (0.522) | |
| $Femceo_{(t-1)}$ | | | | | | 0.000 (0.982) | | | 0.012 (0.273) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 8848 | 8848 | 8848 | 8790 | 8848 | 8848 | 8790 | 8848 | 8848 |
| Adjusted $R^2$ | 0.066 | 0.066 | 0.066 | 0.066 | 0.066 | 0.066 | 0.067 | 0.066 | 0.066 |

This table reports the results from the tobit regression models estimating the number of environmental lawsuits filed in year t using a propensity score matched sample. All variables are defined in Appendix A. *P*-values in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

and variable definitions, industry adjustments, a propensity score matching approach, and replication of prior research findings using securities lawsuits.

This study makes significant contributions to three bodies of literature. First, the findings contribute to the gender literature examining the role of female corporate leadership in determining firm policies (Adams and Ferreira, 2009; Dyreng et al., 2010; Ge et al., 2011; Gul et al., 2011; Huang and Kisgen, 2013; Levi et al., 2014; Lanis et al., 2015; Chen et al., 2016a; Evgeniou and Vermaelen, 2017; García Lara et al., 2017), particularly CSR policies (Bear et al., 2010; Post et al., 2011; McGuinness et al., 2017). This study is distinguishable from prior studies that examine only positive environmental initiatives as proxied by CSR "strength" ratings (Bear et al., 2010; Post et al., 2011; McGuinness et al., 2017). This is the first study to empirically examine actual corporate environmental misconduct as captured by lawsuits. I find novel evidence that greater female board representation is associated with fewer environmental lawsuits. I also identify one mechanism through which board gender diversity can reduce environmental violations, specifically by formulating eco-friendly corporate environmental policies, as evidenced by more environmental strengths and fewer environmental concerns.

Secondly, this study contributes to the corporate governance literature that investigates the factors that mitigate or exacerbate corporate exposure to environmental lawsuits (Kassinis and Vafeas, 2002; Buysse and Verbeke, 2003; Kassinis and Vafeas, 2006). The findings of this study relating to board gender diversity add to the existing evidence on the link between board composition (such as size and independence) and the risk of environmental lawsuits (McKendall, 1999; Kassinis and Vafeas, 2002; Walls et al., 2012). These findings also have significant practical implications for investors wishing to avoid firms with high environmental exposure.

Third, this study contributes to the strand of literature that examines group and organizational dynamics, particularly the role of gender diversity in corporate decision-making (Westphal and Milton, 2000; Erhardt et al., 2003; Konrad et al., 2008; Estélyi and Nisar, 2016). Apart from documenting evidence in support of the critical mass theory (Post et al., 2011; Torchia et al., 2011; Jia and Zhang, 2013), this study provides significant insights into the complementary roles of board gender diversity and CEO gender. The presence of a female CEO is significant in reducing environmental lawsuits only when board gender diversity is otherwise low; conversely, female board representation plays a more important role when the firm is led by a male CEO. In light of the ongoing debates in many countries over the business-case justifications for mandating gender quotas for corporate boards, these findings provide timely evidence to inform policymakers about how board gender diversity and CEO gender complement one another in the boardroom.

One limitation of this study is that it does not directly investigate whether reduced environmental lawsuit frequency is financially beneficial to the firms involved, since the cost of improving environmental performance may exceed the savings from avoiding lawsuits. Recent studies have shown that the relationship between environmental performance and financial performance is not homogeneous and can be influenced by firm-level (Petrenko et al., 2016) and industry-level variations (Iwata and Okada, 2011; Lucas and Noordewier, 2016; Gonenc and Scholtens, 2017). These cross-sectional differences may explain the inconsistent extant findings on the nexus between corporate environmental and financial performance (e.g. Horváthová, 2010; Endrikat et al., 2014). In the light of these challenges, future researchers can further contribute to the literature by examining the roles of firm-specific characteristics in moderating the impacts of environmental misconduct on firms' financial valuation and performance.

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## Appendix A. Variable definitions

| Variable name | Variable definition |
|---|---|
| Env | The number of environmental lawsuits filed in year t. |
| Envd | Dummy variable that equals one if one or more environmental lawsuit(s) is/are filed in year t, and zero otherwise. |
| $Female_{(t-1)}$ | Board gender diversity calculated as the number of female directors on the board divided by the total number of directors in year t-1. |
| $Female_{(t-2)}$ | Board gender diversity calculated as the number of female directors on the board divided by the total number of directors in year t-2. |
| $Female_{(t-3)}$ | Board gender diversity calculated as the number of female directors on the board divided by the total number of directors in year t-3. |
| $Femceo_{(t-1)}$ | Dummy variable that equals one if the gender of the chief executive officer (CEO) is female in year t-1, and zero otherwise. |
| $Femceo_{(t-2)}$ | Dummy variable that equals one if the gender of the CEO is female in year t-2, and zero otherwise. |
| $Femceo_{(t-3)}$ | Dummy variable that equals one if the gender of the CEO is female in year t-3, and zero otherwise. |
| LogTA | Firm size proxied by the natural logarithm of total assets in year t-1. |
| ROA | Firm performance proxied by return on assets, calculated as the net income (loss) divided by total assets in year t-1. |
| Leverage | Financial leverage proxied by debt-to-asset ratio in year t-1, calculated as the book value of total liabilities divided by the book value of total assets. |
| Marketbook | Market-to-book ratio in year t-1, calculated as the market capitalization (closing share price multiplied by common shares outstanding) divided by the book value of total equity. |
| Cash | Cash holdings scaled by total assets in year t-1. |
| AltmanZ | Probability of financial distress in year −1, calculated as 1.2*(working capital/total assets) + 1.4*(retained earnings/total assets) + 3.3*(EBIT/total assets) + 0.6*(total market capitalization/book value of total liabilities) + 1*(sales/total assets). |
| TobinQ | Market value of total assets divided by the book value of total assets in year t-1. The market value of assets is calculated as the book value of total liabilities plus market value of common shares outstanding. |
| Boardsize | The number of directors on the board in year t-1. |
| Boardindep | The proportion of independent directors on the board in year t-1, calculated as the number of independent directors divided by the total number of directors on the board. |
| Blockhold | The percentage of the firm's shares held by institutional block-holders in year t-1. |
| Tenure | The duration of CEO tenure in year t-1. |
| Env_ratings | The overall environmental scores in year t recorded by Kinder Lydenberg Domini (KLD), calculated as the number of environmental strengths minus the number of environmental concerns. |
| Env_strengths | The number of environmental strengths in year t recorded by KLD. |
| Env_concerns | The number of environmental concerns in year t recorded by KLD. |
| $Female3_{(t-1)}$ | Dummy variable representing gender critical mass that equals one if there are three or more female directors on the board in year t-1, and zero otherwise. |
| $Female3_{(t-2)}$ | Dummy variable representing gender critical mass that equals one if there are three or more female directors on the board in year t-2, and zero otherwise. |
| $Female3_{(t-3)}$ | Dummy variable representing gender critical mass that equals one if there are three or more female directors on the board in year t-3, and zero otherwise. |
| $Femindep_{(t-1)}$ | The number of female independent directors on the board divided by the total number of directors in year t-1. |
| $Femindep_{(t-2)}$ | The number of female independent directors on the board divided by the total number of directors in year t-2. |
| $Femindep_{(t-3)}$ | The number of female independent directors on the board divided by the total number of directors in year t-3. |
| $Femindep3_{(t-1)}$ | Dummy variable that equals one if there are three or more female independent directors on the board in year t-1, and zero otherwise. |
| $Femindep3_{(t-2)}$ | Dummy variable that equals one if there are three or more female independent directors on the board in year t-2, and zero otherwise. |
| $Femindep3_{(t-3)}$ | Dummy variable that equals one if there are three or more female independent directors on the board in year t-3, and zero otherwise. |

| | |
|---|---|
| Env_adj | Industry-adjusted number of environmental lawsuits filed in year t, calculated as the number of lawsuits filed less the industry mean of the number of lawsuits filed, computed by year within each one-digit Standard Industry Classification (SIC) code industry. |
| $Female\_adj_{(t-1)}$ | Industry-adjusted board gender diversity in year t-1, calculated as the proportion of female directors on the board (the number of female directors divided by the number of all directors) scaled by the industry mean proportion of female directors on boards, computed by year within each one-digit SIC code industry. |
| $Female\_adj_{(t-2)}$ | Industry-adjusted board gender diversity in year t-2, calculated as the proportion of female directors on the board scaled by the industry mean proportion of female directors on boards, computed by year within each one-digit SIC code industry. |
| $Female\_adj_{(t-3)}$ | Industry-adjusted board gender diversity in year t-3, calculated as the proportion of female directors on the board, scaled by the industry mean proportion of female directors on boards, computed by year within each one-digit SIC code industry. |
| $Femceo\_adj_{(t-1)}$ | Industry-adjusted CEO gender in year t-1, calculated as a dummy variable that equals one if the CEO is female and zero otherwise, less the industry average percentage of firms with female CEOs, computed by year within each one-digit SIC code industry. |
| $Femceo\_adj_{(t-2)}$ | Industry-adjusted CEO gender in year t-2, calculated as a dummy variable that equals one if the CEO is female and zero otherwise, less the industry average percentage of firms with female CEOs, computed by year within each one-digit SIC code industry. |
| $Femceo\_adj_{(t-3)}$ | Industry-adjusted CEO gender in year t-3, calculated as a dummy variable that equals one if the CEO is female and zero otherwise, less the industry average percentage of firms with female CEOs, computed by year within each one-digit SIC code industry. |
| Securities | Dummy variable representing securities fraud allegations, which equals one if the Securities and Exchange Commission issues one or more Accounting and Auditing Enforcement Releases (AAER) against the firm in year t, and zero otherwise. |

All non-binary variables are winsorized at the 1st and 99th percentiles.

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