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Corporate pollution and reputational exposure

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Abstract

We study the empirical association between corporate pollution and reputational exposure using a sample of 745 U.S. firms from 2007 to 2019 and an ordered probit model. Our results reveal an inverse relationship between chemical emissions and reputational exposure rating, after controlling for various firm attributes. We examine the roles of corporate governance structure and the demographic background of the top management team in the transmission process from polluting chemical emissions to reputation. Further, the negative impact of corporate pollution on reputational exposure rating is much stronger in areas where residents are convinced that climate change is happening. We perform several tests and analyses designed to mitigate endogeneity issues and correct sample bias to ensure the robustness of our findings. Finally, our results suggest that the negative effect is stronger for companies with higher information asymmetry, which indicates the importance of information transparency for firms' credibility.

KEYWORDS
climate change beliefs, corporate governance, environment, pollution emissions, reputational exposure

JEL CLASSIFICATION
G30, Q53, Q56

1 INTRODUCTION

It is becoming increasingly clear that climate change poses severe risks to human health and the environment, motivating policymakers to introduce various initiatives that address corporate pollution and combat climate change.[1] Several analyses exist exploring the effect of such environmental-related policies on firms' performance (Dhaliwal et al., 2011), downsizing (Zyglidopoulos, 2005), business activities (Brammer & Pavelin, 2006; Nardella et al., 2020), management strategies (Staw & Epstein, 2000) and board attributes (Bear et al., 2010; Musteen et al., 2010). Recent research suggests that corporate reputation generates a broad range of benefits, illustrating the relationship to exceptional financial performance (Cao et al., 2015; Roberts & Dowling, 2002), market value (Black et al., 2000; Dowling, 2006), perceived importance for executives and environment-related perceptions (Gaganis et al., 2021). We propose and explore a new potential relationship between corporate pollution (i.e. chemical emissions) and corporate reputation assessments. That is, corporate reputation concerns incentivize corporations to align their interests with public concerns and perceptions of the environment. The analysis we conduct is grounded in institutional theory, a well-established framework that has been extensively employed to illustrate how a company's actions are impacted by institutional pressures, such as those related to environmental and social surroundings. Recently, institutional theory has increasingly been applied for analysing climate change, sustainability decisions (Daddi et al., 2016; Glover et al., 2014) and public attention to environmental performance as drivers of reputational assessment (Gaganis et al., 2021). Yet, the profession knows little on whether a company's environmental performance can directly impact its reputation. To explore this question, the present paper studies how a firm's chemical emissions affect its reputational exposure. Furthermore, we identify and evaluate the channels through which chemical emissions impact corporate reputation, namely the corporate governance channel and the climate change beliefs channel.

Our analysis focuses on U.S. firms. We utilize the reputational exposure rating, a corporate risk metric linked to environmental, social and governance (ESG) incidents, provided by RepRisk.[2] The reputational exposure captures the media coverage and public attention towards the company's negative incidents in a direct way. The higher the exposure, the lower the reputational exposure rating. As a metric for environmental performance in our study, we rely on data on toxic chemical releases primarily from the U.S. Environmental Protection Agency (EPA)'s Toxic Release Inventory (TRI). The TRI is a comprehensive database maintained by the EPA that monitors and reports on the toxic chemicals discharged into the environment by industrial facilities operating within the United States. Facilities are legally required to report their annual releases to the TRI if they exceed certain thresholds. This makes the TRI an effective tool for identifying the scale of emissions from each facility. Although TRI reporting is mandatory, the data provided by the companies are self-reported. Despite this, TRI has several advantages, one of which is that it directly measures a company's consideration of its stakeholders' interests because the reporting of emissions is mandatory rather than voluntary.[3] Additionally, by using TRI data, we can examine the effect of chemical pollution on a company's reputational exposure, irrespective of the size of the firm.

To explore the connection between corporate chemical emissions and their reputational exposure, we collect and combine multiple sources of data. First, data on the quantity of toxic chemicals emissions are gathered from the TRI repository published by the U.S. EPA. Because the pollution information from the TRI is based on individual facilities, we match each facility with its parent company and aggregate the facility emissions to obtain each parent company's emissions for a given year. Second, we obtain RepRisk reputational exposure ratings from Wharton Research Data Services (WRDS). Third, we procure financial information for the firms included in our study from Compustat. Last, we obtain corporate governance data from Boardex, ISS and Execucomp. By merging these data sources, we create a comprehensive database with 5978 observations, covering 745 companies over the period 2007–2019. We test our main hypothesis by performing baseline ordered probit regressions of reputational exposure ratings on chemical emissions, while controlling for various corporate attributes and year-fixed effect. Our analysis reveals that in all the specifications, the chemical emissions coefficients are significantly negative at the 1% level. The results indicate that firms with higher levels of chemical discharges are more susceptible to reputational damage, as indicated by a lower reputational exposure rating. Based on agency theory and upper echelons theory, we then proceed to investigate how corporate governance acts as a channel through which chemical emissions can impact a firm's reputational exposure. Our findings reveal that the connection between pollution and reputation is impacted by the corporate governance framework and the top management team's demographic background. Corporate governance features, such as the size and independence of the board, a staggered board, CEO total compensation, CEO duality and CEO gender, moderate the association between corporate pollution and reputational exposure. These results indicate that both the corporate governance structure and managerial demographic profile can exacerbate or mitigate public concerns regarding the firm's environmental reputation. We further study the moderating effect of community climate change beliefs and find that the local residents' attention and perspectives toward climate change risk can exacerbate the reputational exposure of polluting firms. The negative impact of chemical emissions on the reputational exposure rating is much stronger in areas where residents are convinced that climate change is happening.

We conduct a series of robustness checks to tackle possible endogeneity issues, and our findings still hold. We utilize two alternative metrics to measure corporate pollution and obtain consistent results. We also apply two-stage least squares regressions to correct for potential biases that may arise from omitted variables and self-selection. Moreover, we use the Reputational Exposure Index as a substitute for the reputational exposure rating to further account for possible measurement errors. Additional analysis indicates that the adverse impact of pollution on reputation is amplified for companies with higher information asymmetry (as indicated by the annual average quoted bid–ask spread). Besides, the ratification of the Paris Agreement was followed by decreased corporate reputational exposure rating.

Our paper complements the relevant literature from two perspectives. First, we investigate the impact of environmental performance disclosure on reputational exposure. Our results demonstrate that the public scrutinizes companies, and those with elevated chemical emissions suffer greater harm to their reputation. These findings carry crucial policy implications, highlighting the necessity for community participation in promoting ethical conduct among local firms. Second, we study how different corporate governance features alleviate or exacerbate the impact of corporate pollution on reputation. We consider two dimensions, focusing on the corporate governance structure and the demographic background of the top management team. We also examine how public awareness of climate change shape the link between pollution and reputation. Our findings provide a characterization that should attract the attention of various groups, including company stakeholders such as policymakers, shareholders, executives and potential investors.

The remainder of this paper is organized as follows. The next section covers the theoretical background and formulates the hypotheses. Section 3 provides details on the construction of the dataset and describes the methodology. The empirical results are outlined and discussed in Section 4, while Section 5 concludes.

2 | LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

There is growing literature examining corporate reputation and its associated risks. As per Brammer and Pavelin (2006) findings, various elements play a crucial role in shaping a company's corporate reputation, such as its financial and social performance, degree of institutional ownership over a prolonged period, market risk, and the type of business activities it conducts. Research indicates that incorporating sustainable practices can aid in enhancing a company's reputation, as it provides a competitive edge over others. Such practices can help a company build a positive image, which, in turn, can influence its reputation and brand value (Melo & Garrido-Morgado, 2012). Additionally, the influence of a company's social performance on its reputation may vary across industries and within a particular industry. Studies have suggested that companies that align their social initiatives with the interests of their stakeholders can enhance their reputation &(e.g. Brammer and Pavelin, 2006).

Earlier studies argue that a company's environmental performance can positively impact its reputation and help build its image (Arendt & Brettel, 2010; Alon & Vidovic, 2015; Dögl & Holtbrügge, 2014; Hult et al., 2018; Irfan et al., 2018; Miles & Covin, 2000). Conversely, engaging in irresponsible economic, social or environmental conduct can result in consumers developing a negative perception of a company (Lin et al., 2016). However, other studies find no significant connection between a company's social performance and its reputation (Soleimani et al., 2014), or that environmental efforts do not significantly impact stakeholders' perception of a company's reputation (D'Souza et al., 2013). Discharging chemicals into the environment can cause harmful consequences for the ecosystem and the health of individuals residing in close proximity. Companies that engage in environmentally harmful practices may face financial penalties and costs for cleaning up their emissions, as well as losses from damage to their reputation, limitations on their production or closure (Attig et al., 2013; Schneider, 2011). As a result, it is likely that companies with higher chemical emissions may have a poor fit with societal expectations, and their reputations may be negatively impacted. Thus, in this scenario, we would expect that a negative association exists between chemical emissions and corporate reputational exposure ratings. Thus, we propose our first hypothesis:

Hypothesis 1. There is a negative association between chemical emissions and reputational exposure rating.

However, certain studies propose that people's perceptions of a company's reputational risk are influenced by the information that is disclosed to the public (Pineiro-Chousa et al., 2017; Pérez-Cornejo et al., 2020). For instance, Pérez-Cornejo et al. (2020) contend that the quality of a company's corporate social responsibility (CSR) reporting can impact the association between its environmental and social performance and its reputation. Additionally, Branco and Rodrigues (2006) argue that a company's engagement in and disclosure of CSR can either improve or harm its reputation. Different from these studies, this paper concentrates on the environmental dimension of CSR and investigates how the mandatory reporting of a company's pollution influences its reputational exposure rating. Another important topic in recent literature is the role of corporate governance in determining a company's overall performance (Bhagat & Bolton, 2008; Bernile et al., 2018; Bhagat & Bolton, 2019) and particularly its environmental dimension (Beji et al., 2021; Liao et al., 2015; Úbeda-García et al., 2021). Theories like agency theory and resource dependence theory provide a perspective on how the attributes of a board of directors can impact both firm's CSR and reputation (Bear et al., 2010). The public's perception of a corporation's environmental performance may vary depending on the company's particular governance structures and procedures (Bear et al., 2010).

Studies demonstrate that the risks associated with the interaction between management and external stakeholders, including agency and information risks, can augment the overall risk of a corporation (Bhojraj & Sengupta, 2003; Francis et al., 2012; Ge et al., 2012). As per agency theory, a corporation's board of directors has a critical responsibility of supervising its management team for the benefit of its shareholders (Eisenhardt, 1989; Fama & Jensen, 1983), since managers may ignore their responsibilities and put their own interests ahead of stakeholders. The goal of corporate governance is to synchronize the objectives of managers with the welfare of stakeholders (Shleifer & Vishny, 1997; Tirole, 2010), and effective corporate governance can assist firms in mitigating agency risks by enhancing managerial oversight and preventing self-dealing. In companies with strong corporate governance, where the interests of managers and stakeholders are aligned, the public may rely on information provided by management to evaluate the company's reputational risk, without being overly concerned about agency risks. Additionally, well-governed firms with transparent reporting and disclosure have lower information risk, further reducing reputational exposure. Resource dependence theory argues that a company's board of directors is vital in supplying resources like legitimacy, expertise and advice to the company (Hillman & Dalziel, 2003). This aids the company in comprehending and addressing the environment (Boyd, 1990), which can ultimately result in better environmental performance and reputational exposure management.

To ensure effective oversight of management, the board of directors must possess suitable composition and abilities to assess management decisions and their influence on the company's reputation. According to Walls et al. (2012), a greater degree of board independence, diversity and size are adversely related to environmental performance. Boards with smaller and more diverse compositions seem to be better able to mitigate negative environmental performance. Although independent boards are generally beneficial for a company's financial performance, the same may not be true for its environmental practices (Walls et al., 2012). Likewise, Kassinis and Vafeas (2002) find that boards with fewer members tend to have fewer environmental violations, possibly because large boards inhibit the free exchange of ideas and may also be vulnerable to exploitation by opportunistic CEOs (Goodstein et al., 1994). Conversely, certain research suggests that companies which exhibit a higher degree of board independence and have fewer directors chosen by the CEO typically exhibit superior environmental performance (De Villiers et al., 2011). Similarly, Brammer and Pavelin (2006) propose that external stakeholders' interests may be better reflected by non-executive independent board members, resulting in improved environmental disclosure. However, this connection is not supported by the evidence. Furthermore, Iliev and Roth (2023) discover that ESG performance is enhanced in U.S. firms that have directors who are affected by modifications in regulations and reporting obligations. Consistent with resource dependence theory, De Villiers et al. (2011) suggest that an improved environmental performance is observed in corporations with larger boards, more legal experts and more actively involved CEOs on board. In the same vein, Bear et al. (2010) propose that a more diverse range of resources on the board results in improved comprehension and problem-solving abilities, allowing the board to tackle business challenges and establish a responsible corporate image. According to Musteen et al. (2010), board attributes significantly impact how the public perceives a corporation's reputation. They state that companies with a higher number of independent directors on their board and larger board sizes typically enjoy a more favourable reputation (Musteen et al., 2010).

Although voluminous literature exists, there is still no consensus on how CEO duality affects a company's environmental behaviour. Walls et al. (2012) highlight that the most substantial environmental performance is witnessed when a company's CEO also serves as the board chair, and the board has a higher proportion of inside directors, suggesting that a powerful CEO, when supported by an insider-heavy board, can prioritize environmental goals. Nevertheless, this is not the case when the board is independent (Walls et al., 2012). In contrast, Webb (2004) reports that there is an inverse association between CEO duality and CSR. However, other research, such as that conducted by McKendall et al. (1999) and Berrone et al. (2010), observes no significant connection between the level of CEO power and a firm's environmental conduct.

Some research suggests that CEO compensation can influence a company's likelihood of engaging in environmentally friendly practices. CEO salary is said to be negatively associated with the company's environmental practices (Coombs & Gilley, 2005) and reputation (Stanwick & Stanwick, 2001). According to Harjoto et al. (2015), CEOs who work for companies with superior ESG performance receive reduced compensation. This finding suggests that even if CEOs are engaging in rent-seeking behaviour, investing in ESG activities can act as a replacement for their salary instead of an addition to it (Harjoto et al., 2015). Likewise, firms with higher CEO salaries are found not to perform as well environmentally (Jian & Lee, 2015), possibly because their CEOs prioritize shorter-term objectives, such as financial gains, rather than environmental concerns (Walls et al., 2012). Moreover, McGuire et al. (2003) report that compensation incentives such as stock options are connected to inferior environmental performance. However, separate studies indicate that CEO remuneration over the long haul has a positive connection with corporate social performance and an adverse association with fraudulent reporting (Deckop et al., 2006).

Along similar lines, numerous studies have investigated the significance of the board of directors and its direct effect on various organizational performances, including corporate environmental outcomes. According to Walls and Hoffman (2013), the range of actions undertaken by an organization to promote environmental sustainability is primarily influenced by the board's direction. González-Benito and González-Benito (2010) focus on the capability and willingness of managers to perceive and prioritize environmental demands from stakeholders and determine that managers may exhibit varying levels of attention towards these demands. Daddi et al. (2016) state that businesses with greater awareness of the impact of climate change among managers are more inclined to implement both mitigation and adaptation strategies. This aligns with the upper echelons theory, which proposes that the profiles of the top management team, such as their backgrounds, play a part in predicting organizational results, including both strategic decisions and performance (Hambrick & Mason, 1984). This theory indicates that the identifiable traits of top managers, including their age, educational qualifications, professional background and socio-economic status, act as signals for their perspectives, outlooks and values, as well as for intangible psychological aspects that are challenging to measure, such as their aptitude for leading and building effective teams. Research on how executive team demographics affect corporate environmental performance and reputation is a fast-growing field. Kassinis and Panayiotou (2006) discover that there is a direct correlation between the significance given by CEOs to stakeholder engagement in environmental strategies and the environmental performance of their organizations. According to the research by Lewis et al. (2014), the probability of a firm voluntarily revealing environmental information is influenced by the CEO's education and tenure. Their study indicates that companies headed by CEOs holding an MBA degree have a greater tendency to reveal their environmental information to the Carbon Disclosure Project (CDP) than those led by CEOs with a legal background (Lewis et al., 2014) suggest that businesses headed by female CEOs generally exhibit superior environmental performance, such as reduced pollution, lower greenhouse gas emissions and fewer penalties for violating environmental regulations. Additionally, Bear et al. (2010) highlight that the existence of women on a company's board has a favourable effect on its reputation. Studies also indicate that CEOs who are younger are more prone to heading companies that have robust ESG profiles (e.g. Borghesi et al., 2014). Hence, we propose the second hypothesis as follows:

Hypothesis 2. Weak corporate governance structure and managerial demographic background exacerbates the negative relationship between corporate chemical emissions and reputational exposure rating.

We expect that if chemical emissions contribute to harming a company's reputation by intensifying agency risk, the impact on reputational exposure rating should be more noticeable in organizations with inadequate corporate governance. Although a rapidly growing literature investigates the connection between corporate governance and environmental behaviour, no evidence exists, to the best of our knowledge, regarding how corporate governance impacts the emissions–reputation relationship.

In recent years, the rising awareness of the detrimental impact of human activities on the Earth's ecosystem has led to heightened public concern and focus on climate change. Research has examined the degree of public apprehension regarding climate change and how it affects asset pricing in both asset and mortgage markets, specifically in relation to sea-level rise (SLR) risk (e.g. Baldauf et al., 2020; Nguyen et al., 2022). The findings imply that people's perspectives about climate change can influence how markets determine the value of assets, particularly those in coastal areas, due to the potential damage that SLR can cause. Companies are facing increased pressure from stakeholders to take more responsibility for their environmental impacts and are being closely monitored for their environmental performance. Individuals with stronger convictions about climate change are more likely to have negative views of companies that engage in environmentally damaging practices such as producing high levels of pollution. As a consequence, companies that operate in areas where climate change awareness is high will experience increasing pressure to improve their environmental performance to maintain their image and reputation. The third hypothesis is stated as follows:

Hypothesis 3. The adverse association between corporate chemical emissions and reputational exposure rating is more pronounced if companies operate in states with higher levels of climate change beliefs.

We propose that the inverse impact of corporate pollution on their reputational exposure rating should be stronger for firms situated in areas where climate change beliefs are more prevalent. Despite growing research examining the effect of climate change beliefs on asset pricing, there is currently no evidence on how community awareness of climate change impacts the connection between corporate pollution and reputation.

3 | RESEARCH DESIGN

3.1 | Sample construction

The information on corporate reputational exposure is sourced from RepRisk which evaluates the ESG risk exposure of firms globally by systematically monitoring negative events, criticisms and conflicts from over 100,000 sources on a daily basis. RepRisk follows a five-step procedure which involves screening, identification and filtering, analysing, quality assurance and quantification to gather and assess the data. Each risk incident is evaluated based on its severity and the reach of the information source according to RepRisk's rating system. Each company is assigned a reputational exposure rating, represented by a letter grade ranging from *AAA* (representing high quality/low reputational risk) to *D* (indicating low quality/high reputational risk), which facilitates bench-marking and integration of ESG and business conduct risks. Consistent with prior research on credit ratings (e.g. Ashbaugh-Skaife et al., 2006; Gaganis et al., 2021), we transform the reputational exposure rating to a numeric scale ranging from 1 to 10. The higher the number, the better the quality and the lower the reputational risk. The specific conversion used is as follows: $D = 1$, $C = 2$, $CC = 3$, $CCC = 4$, $B = 5$, $BB = 6$, $BBB = 7$, $A = 8$, $AA = 9$ and $AAA = 10$.

The main explanatory variable used to test Hypothesis 1 is Chemical Emissions/Total Assets,[4] measured as the firm-size standardized amount of toxic chemical releases from the TRI basic dataset, which is maintained by the EPA.[5] The TRI programme collects data regarding the discharge of hazardous chemicals from over 40,000 plants in the United States. The industrial plants included in the database are involved in manufacturing, mining, power generation, chemical manufacturing and hazardous waste treatment, have more than 10 full-time employees, and use or produce more than the specified threshold levels of TRI-listed toxic substances. These plants must report their releases of toxins to the TRI, and the TRI publishes self-reported toxic emissions data at the plant level, along with information on the physical location of the plant and the name of its parent company. In this study, we take into account the size of the company when measuring the total chemical emissions to determine the environmental performance in relative terms. This is because, first, larger companies in various industries are more prone to environmental risks, and tend to receive more public attention and media coverage. Therefore, the main variable of interest is *the ratio of the total toxic chemical releases to the firm's total assets*, denoted as Chemical Emissions/Total Assets.[6] Additionally, we examine two alternative metrics of corporate pollution, *the ratio of the total toxic chemical releases to the company's total net income* (Chemical Emissions/Net Income) and *the ratio of the total amount of toxic chemical releases to the corporation's total sales* (Chemical Emissions/Total Sales), to assess whether the findings remain consistent.

Our regression analysis controls for several firm financial characteristics. We obtain data on corporate attributes from Compustat, including ROA (*profitability*), leverage, Tobin's *Q* (*financial performance*), tangibility and firm size. Appendix A provides variable definitions. To explore alternative explanations for the effect of corporate pollution on reputational exposure ratings, we test the governance channel using variables related to corporate governance structure and managerial demographic background. Additionally, we consider the level of concern toward climate change in the community and investigate the climate change beliefs channel.

The process of combining these databases at the company level is challenging due to the absence of standard keys that can be used to link the EPA TRI report, RepRisk and Compustat/Boardex/Execucomp databases. We overcome this by the following steps. First, we connect EPA TRI parent firm information with the Compustat/Boardex/Execucomp databases by applying a parent name-matching algorithm that incorporates historical name data. Historical name data is necessary as it changes over time due to various reasons such as plant closures and ownership changes. We gather historical firm names from CRSP and supplement them by obtaining the historical name and location details from 8-K, 10-K and 10-Q filings. In the second step, we convert firm ID data from the RepRisk database to GVKEY, which is used to link RepRisk with the updated dataset from the previous phase. Our final sample includes 5978 observations for 745 unique U.S. companies spanning the years 2007–2019. We use 1-year lagged values of *Chemical Emissions/Total Assets* and control variables when predicting the effect on reputational exposure rating.

3.2 | Methodology

3.2.1 | Effect of chemical emissions on corporate reputational exposure rating

To investigate how chemical emissions affect reputational exposure (Hypothesis 1), we develop a model that expresses the reputational exposure rating as a function of emissions and company-specific attributes. Given that our categorical dependent variable has an ordinal nature, we employ an ordered probit model to generate empirical evidence. Our method is in line with the existing research on reputation, as demonstrated in previous studies (see, e.g. Gaganis et al., 2021), and is also congruent with the literature on credit ratings (e.g. Khatami et al., 2016; Papadimitri et al., 2020). The reputational exposure rating employs ordered partitions of a latent continuous variable that is a linear equation of the independent variables. Our baseline regression model is specified as follows:

$$\{Reputational\ Exposure\ Rating\}_{i,t} = \alpha_0\{Chemical\ Emissions/Total\ Assets\}_{i,t-1} + \sum_{k=1}^{k}\beta_k X_{i,t-1} + \gamma_t + \epsilon_{i,t} \quad (1)$$

$$\{Reputational\ Exposure\ Rating\}_{i,t} = \begin{cases} 1, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in (-\infty, \mu_1) \\ 2, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in [\mu_1, \mu_2) \\ 3, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in [\mu_2, \mu_3) \\ 4, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in [\mu_3, \mu_4) \\ 5, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in [\mu_4, \mu_5) \\ 6, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in [\mu_5, \mu_6) \\ 7, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in [\mu_6, \mu_7) \\ 8, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in [\mu_7, \mu_8) \\ 9, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in [\mu_8, \mu_9) \\ 10, & if\ \{Reputational\ Exposure\ Rating\}^*_{i,t} \in (\mu_9, +\infty) \end{cases}$$

where $\{Reputational\ Exposure\ Rating\}^*_{i,t}$ is the unobserved reputational exposure rating linking variable. $\{Chemical\ Emissions/Total\ Assets\}_{i,t-1}$ is the main variable of interest, environmental performance, measured as the ratio of the total toxic chemical releases to total assets for company *i* in year *t* − *1*; and $X_{i,t-1}$ includes several control variables for company *i* in year *t* − *1*. γ_t accounts for year fixed effect to adjust for any systematic variations in the reputational exposure rating standards across years. $\epsilon_{i,t}$ refers to a random error. In all specifications, *t*-statistics are heteroskedastic and we cluster robust standard errors at the company-level (Petersen, 2009). μ_1 to μ_9 are the threshold parameters and $\{Reputational\ Exposure\ Rating\}_{i,t}$ is the observed reputational exposure rating of firm *i* in year *t*.

3.2.2 | Corporate governance channel

If the channel through which chemical emissions expand reputational exposure is by intensifying agency risk, their adverse impact on reputational exposure rating should be more pronounced in companies with weak corporate governance (Hypothesis 2). We incorporate essential governance structure variables in our regression models, including board independence, board size, CEO compensation, CEO duality and a staggered board indicator. These variables have been identified by previous research as important factors to consider in corporate governance (Bebchuk et al., 2009; Chen et al., 2021). Furthermore, building upon research on managerial demographic background, we adopt the approach of Bear et al. (2010) and Gaganis et al. (2021) and investigate the impact of various types of CEO and corporate board characteristics, such as CEO gender, board age diversity, board nationality composition, board gender ratio and board education qualifications diversity. These proxies are observable characteristics of top managers that are challenging to measure or observe. To assess these effects, we condition the chemical emissions variable on corporate governance characteristics. The regression function is formulated as follows:

$$\begin{aligned}\{Reputational\ Exposure\ Rating\}_{i,t} = {} & \alpha_0\{Chemical\ Emissions/Total\ Assets\}_{i,t-1} \\ & + \alpha_1\{Chemical\ Emissions/Total\ Assets\}_{i,t-1} \times \{Corporate\ Governance\}_{i,t-1} \\ & + \alpha_2\{Corporate\ Governance\}_{i.t-1} + \sum_{k=1}^{k} \beta_k X_{i,t-1} + \gamma_t + \epsilon_{i,t} \end{aligned} \quad (2)$$

in which $\{Corporate\ Governance\}_{i,t-1}$ represents the corporate governance and demographic background variables of company *i* in year *t* − *1*.

As discussed, we anticipate that poor corporate governance can further exacerbate the effect of toxic emissions on reputational exposure, increasing public concern regarding the firm's environmental practices, and therefore amplifying the negative relationship between emissions and reputation.

3.2.3 | Climate change beliefs channel

If chemical emissions enlarge reputational exposure, their detrimental effect on reputational exposure rating should be more discernible for firms situated in communities where climate change is a greater concern for the public (Hypothesis 3). The reason for this is that individuals in such areas are likely to be well-informed about the issue of climate change and may hold companies accountable for their contributions to the phenomenon. Furthermore, firms situated in regions where climate change is a significant concern will be under increased scrutiny from both stakeholders and the media, which could amplify the negative impact of their emissions on their reputation. To test this channel, we condition the chemical emissions variable on public climate change beliefs. The regression model is presented as

$$\begin{aligned}\{Reputational\ Exposure\ Rating\}_{i,t} = {} & \alpha_0\{Chemical\ Emissions/Total\ Assets\}_{i,t-1} \\ & + \alpha_1\{Chemical\ Emissions/Total\ Assets\}_{i.t-1} \times \{Climate\ Change\ Beliefs\}_{i,t-1} \\ & + \alpha_2\{Climate\ Change\ Beliefs\}_{i,t-1} + \sum_{k=1}^{k} \beta_k X_{i,t-1} + \gamma_t + \epsilon_{i,t} \end{aligned} \quad (3)$$

in which $\{Climate\ Change\ Beliefs\}_{i,t-1}$ represents the indicator variables including *Happen* (an indicator variable that takes a value of 1 if the proportion of individuals in the state who answered 'yes' to the question of whether they believe that climate change is happening is higher than the median value of the sample, and 0 otherwise), *Worried* (an indicator variable that takes a value of 1 if the proportion of individuals in the state who answered 'yes' to the question of whether they are worried about global warming is higher than the sample's median, and 0 otherwise) and *Harm* (an indicator equals 1 if the percentage of individuals in the state who answered 'yes' to the question of whether they think global warming will harm people in the United States is greater than the sample's median, and 0 otherwise).

We expect that the extent of the community's climate change belief moderates the association between toxic emissions and reputational exposure ratings, making the adverse impact of corporate pollution on reputation more pronounced in regions with strong public concern for climate change.

4 | EMPIRICAL RESULTS

4.1 | Summary statistics

Table 1 presents a thorough breakdown of the average reputational exposure rating and chemical emissions by industry based on two-digit Standard Industrial Classification (SIC) codes. In the sample, the chemical industry (SIC 28) makes up 13.47% of the total, while the industrial and commercial machinery and computer equipment (SIC 35), electric, gas and sanitary services (SIC 49), and transportation equipment (SIC 37) industries follow closely with 10.49, 10.20 and 8.80%, respectively. This distribution is in line with what is generally anticipated because these four industries are known for their pollution-intensive nature.

Table 2 provides summary statistics for reputational exposure rating, corporate pollution and other firm-specific control variables used in this paper. To alleviate the impact of outliers, the variables are winsorized at the 1st and 99th percentiles, except for the *Reputational Exposure Rating*. The major variable of interest is the natural logarithm of chemical emissions standardized by firm size *Chemical Emissions/Total Assets*. Additionally, two alternative measures of corporate pollution are considered to verify the robustness of our findings. These are *Chemical Emissions/Net Income* and *Chemical Emissions/Total Sales*. *Chemical Emissions/Net Income* is the natural logarithm of the total toxic chemical releases standardized by corporate total net income, and *Chemical Emissions/Total Sales* is the natural logarithm of the total toxic chemical releases standardized by firm's total sales. The mean values of chemical emissions measurements (*Chemical Emissions/Total Assets*, *Chemical Emissions/Net Income* and *Chemical Emissions/Total Sales*) are 2.561, 0.651 and 2.791, respectively, and these measures have large standard deviations of 3.342, 3.427 and 3.364, respectively, indicating a high level of variability in the total emissions of firms after adjusting for differences in firm size. The mean value of *Reputational Exposure Rating* is 8.106, and its standard deviation is 1.440. In terms of firm attributes, the mean *ROA*, *Leverage*, *Tobin's Q*, *Tangibility* and *Firm size* are 0.044, 0.265, 1.685, 0.315 and 8.628, respectively.

Table 3 displays the Spearman correlation matrix for all the variables discussed in Section 3. As anticipated, the Spearman correlation coefficient between chemical emissions (*Chemical Emissions/Net Income*) and the *Reputational Exposure Rating* is negative −0.145 (−0.158), in line with the expected inverse relationship between chemical emissions and reputational exposure rating. The Spearman correlation coefficient between *Chemical Emissions/Total Assets* (*Chemical Emissions/Total Sales*) and *Reputational Exposure Rating* is positive, 0.131 (0.107). All of the correlations mentioned above are statistically significant at the 1% level. Nevertheless, it is important to interpret these correlation coefficients with care as they do not account for other characteristics of the companies in the cross-section. To delve deeper into the multivariate impact of additional firm-specific control variables on the association between pollution and reputation, we describe our multivariate regressions in the following subsection.

4.2 | Baseline model

Table 4 provides the regression results for the baseline model, which explores the impact of corporate pollution on reputational exposure rating, as specified in Equation (1). The coefficient on *Chemical Emissions/Total Assets* is significantly negative at the 1% level, suggesting that corporations with higher chemical emissions tend to receive lower reputational exposure ratings (higher reputational exposure). This finding is in agreement with Hypothesis 1, as specified in Section 2, that is, our empirical results propose that higher chemical emissions lead to a poorer reputational exposure rating. To ensure the robustness of this baseline evidence, we also take into account two alternative measures of corporate pollution, namely Chemical Emissions/Net Income and Chemical Emissions/Total Sales. The supplementary results in both specifications (2) and (3) illustrate a negative link between corporate pollution and reputation. More precisely, the coefficients for both variables are negative at a statistical significance level of 5% or better. This effect remains consistent when taking into account various financial characteristics at the firm level. We demonstrate that

TABLE 1 Industry distribution.

Two-digit SIC	Description	Number of obs	% of obs
1	Agricultural production – crops	13	0.22%
10	Metal mining	103	1.72%
12	Coal mining	44	0.74%
13	Oil and gas extraction	145	2.43%
14	Mining and quarrying of nonmetallic minerals, except fuels	45	0.75%
15	Construction – general contractors and operative builders	7	0.12%
16	Heavy construction, except building construction, contractor	17	0.28%
17	Construction – special trade contractors	19	0.32%
20	Food and kindred products	297	4.97%
21	Tobacco products	29	0.49%
22	Textile mill products	34	0.57%
23	Apparel, finished products from fabrics and similar materials	20	0.33%
24	Lumber and wood products, except furniture	96	1.61%
25	Furniture and fixtures	64	1.07%
26	Paper and allied products	231	3.86%
27	Printing, publishing and allied industries	25	0.42%
28	Chemicals and allied products	805	13.47%
29	Petroleum refining and related industries	133	2.22%
30	Rubber and miscellaneous plastic products	84	1.41%
31	Barter transactions involving advertising services	7	0.12%
32	Stone, clay, glass and concrete products	90	1.51%
33	Primary metal industries	249	4.17%
34	Fabricated metal products	188	3.14%
35	Industrial and commercial machinery and computer equipment	627	10.49%
36	Electronic and other electrical equipment and components	477	7.98%
37	Transportation equipment	526	8.80%
38	Measuring, photographic, medical, and optical goods and clocks	468	7.83%
39	Miscellaneous manufacturing industries	17	0.28%
40	Railroad transportation	4	0.07%
42	Motor freight transportation	8	0.13%
44	Water transportation	19	0.32%
45	Transportation by air	12	0.20%
46	Pipelines, except natural gas	15	0.25%
47	Transportation services	4	0.07%
48	Communications	9	0.15%
49	Electric, gas and sanitary services	610	10.20%
50	Wholesale trade – durable goods	77	1.29%
51	Wholesale trade – non-durable goods	100	1.67%
53	General merchandise stores	9	0.15%

(Continues)

TABLE 1 (Continued)

Two-digit SIC	Description	Number of obs	% of obs
54	Building materials, hardware, garden supplies and mobile homes	20	0.33%
55	General merchandise stores	6	0.10%
56	Food stores	8	0.13%
58	Eating and drinking places	5	0.08%
59	Miscellaneous retail	19	0.32%
62	Security and commodity brokers, dealers, exchanges and services	16	0.27%
64	Insurance agents, brokers and service	7	0.12%
65	Real estate	6	0.10%
67	Holding and other investment offices	19	0.32%
73	Business services	36	0.60%
80	Health services	6	0.10%
82	Educational services	3	0.05%
87	Engineering, accounting, research and management services	42	0.70%
99	Non-classifiable establishments	58	0.97%
Total		5978	100.00%

Note: This table presents the distribution of sample firms by industry, based on the first two digits of their Standard Industrial Classification (SIC) codes. The sample consists of 5978 firms-year observations between 2007 and 2019 for 745 individual firms.

companies with low market value, high leverage and high profitability tend to have high reputational exposure ratings. Additionally, the level of reputational exposure rating is negatively related to firm size, which is consistent with findings from earlier research (e.g. Gaganis et al., 2021).

4.3 | Corporate governance and climate change beliefs channels

This subsection investigates how corporate governance and local climate change beliefs affect the relationship between corporate pollution and reputation.

To investigate the moderating roles of the corporate governance structure and top management team profiles, we adopt a similar approach to previous research (Hoechle et al., 2012; Lin et al., 2013) by incorporating a series of key variables, including *Board independence* (the fraction of outside directors), *Board size* (the natural logarithm of the count of directors that serve on the board of a company), *CEO compensation* (the natural logarithm of the CEO's total compensation) and *CEO duality* (an indicator takes a value of 1 if the CEO simultaneously holds the positions of CEO and board chairman, and 0 otherwise). We also examine the impact of having a *Female CEO* (an indicator for CEO gender) and a *Staggered board* (an indicator takes a value of 1 when a company's board of directors is structured into multiple classes, usually three, where each class is elected to overlapping terms, and 0 otherwise); these are considered to be important factors influencing corporate strategy (Amihud & Stoyanov, 2017; Bear et al., 2010).

The findings in Table 5 illustrate that the link between a company's chemical emissions and its reputational exposure is affected by corporate governance characteristics. Poor corporate governance amplifies agency risk and, consequently, exacerbates the adverse impact of chemical emissions on reputational exposure ratings while strong corporate governance mitigates this impact. This supports the idea that chemical emissions can further damage public opinion and lower reputational exposure ratings when a company has weak governance. Ceteris paribus, the negative

TABLE 2 Summary statistics.

	Observations	Mean	SD	Min	25th	50th	75th	Max
Reputational Exposure Rating	5978	8.106	1.440	1.000	8.000	9.000	9.000	10.000
Chemical Emissions	5978	11.189	3.414	3.086	9.117	11.633	13.712	16.254
Chemical Emissions/Total Assets	5978	2.561	3.342	−8.708	0.464	2.946	5.154	11.555
Chemical Emissions/Net Income	5978	0.651	3.427	−7.662	−1.429	1.092	3.182	7.959
Chemical Emissions/Total Sales	5955	2.791	3.364	−8.330	0.849	3.141	5.263	11.468
ROA	5978	0.044	0.079	−0.379	0.021	0.048	0.082	0.236
Leverage	5978	0.265	0.157	0.000	0.164	0.265	0.347	0.821
Tobin's *Q*	5978	1.685	0.814	0.694	1.135	1.462	1.960	5.644
Tangibility	5978	0.315	0.216	0.023	0.139	0.252	0.448	0.842
Firm size	5978	8.628	1.549	4.700	7.569	8.556	9.713	12.156
Board independence	5978	83.099	10.442	0.000	81.818	85.714	88.889	100.000
Board size	5978	2.281	0.212	0.693	2.197	2.303	2.398	2.944
Staggered board	5978	0.284	0.451	0.000	0.000	0.000	1.000	1.000
CEO duality	5978	0.395	0.489	0.000	0.000	0.000	1.000	1.000
CEO compensation	5978	8.604	0.732	6.398	8.268	8.544	9.084	10.064
Female CEO	5978	0.031	0.173	0.000	0.000	0.000	0.000	1.000
Spread	5978	0.066	1.273	0.004	0.011	0.015	0.028	78.831
Happen	5978	60.172	5.217	47.788	52.635	60.378	64.249	84.035
Worried	5]978	54.912	6.831	40.495	49.630	54.393	59.672	75.089
Harm	5978	55.485	5.356	44.205	51.477	54.667	58.946	72.069

Note: This table presents summary statistics for all research variables used in this study. The sample period is from 2007 to 2019. Definitions of all variables are provided in the Appendix. All continuous variables are winsorized at the 1 and 99% percentiles to control for outliers. '25th', '50th' and '75th' denote percentiles.

effect of corporate pollution on reputational exposure ratings is intensified when the company has fewer independent directors, a smaller board, a male CEO, lower CEO compensation and more limitations on shareholder influence in management (a staggered board). The coefficients of the interaction terms between chemical emissions and these factors are statistically significant at the 5 or 1% level. The results align with the literature suggesting that chemical emissions increase corporate costs by exacerbating agency risk, particularly in companies with weak governance (Chen et al., 2021). Lastly, we observe no indication of conditional effects from the other corporate governance variables (results untabulated).

A company's reputation is not formed in isolation but is shaped by the wider perceptions of the public. Therefore, it would be worthwhile to explore the influence of community perspectives regarding climate change on a company's emissions and reputation trajectory. We use the Yale Climate Opinion Map, which has been referenced in previous research (Baldauf et al., 2020; Howe et al., 2015; Nguyen et al., 2022), to measure state-level climate change beliefs. This publicly available map reports opinions gathered from survey responses. The data commence in 2014 and is updated biennially. Our main sample period is from 2007 to 2019, so we rely on the 2014 survey data as the earliest available data to include in our analysis.[7] Among the states included in our sample, the median percentage of surveyed participants who reported believing in the occurrence of climate change is 60.38%. There is a substantial variation between states; the lowest proportion of respondents who are certain that climate change is occurring is in West Virginia, 54%, and the highest proportion is in the District of Columbia, 81%. The standard deviation is 5.37%. Our primary climate change beliefs measurement is *Happen*, an indicator that takes a value of 1 if the proportion of respondents in the state who answer 'yes' to the question of whether they believe that climate change is happening

TABLE 3 Correlation matrix.

	Reputational Exposure Rating	Chemical Emissions	Chemical Emissions/Total Assets	Chemical Emissions/Net Income	Chemical Emissions/Total Sales	ROA	Leverage	Tobin's Q	Tangibility	Firm size	Board independence
Reputational Exposure Rating	1.000										
Chemical Emissions	-0.145^{***}	1.000									
Chemical Emissions/Total Assets	0.131^{***}	0.874^{***}	1.000								
Chemical Emissions/Net Income	-0.158^{***}	0.999^{***}	0.867^{***}	1.000							
Chemical Emissions/Total Sales	0.107^{***}	0.897^{***}	0.979^{***}	0.891^{***}	1.000						
ROA	-0.052^{***}	-0.085^{***}	-0.100^{***}	-0.076^{***}	-0.137^{***}	1.000					
Leverage	0.027^{**}	0.025^{*}	0.011	0.022	0.003	-0.154^{***}	1.000				
Tobin's Q	0.001	-0.107^{***}	-0.089^{***}	-0.105^{***}	-0.101^{***}	0.347^{***}	0.007	1.000			
Tangibility	−0.016	0.382^{***}	0.354^{***}	0.380^{***}	0.413^{***}	-0.198^{***}	-0.113^{***}	-0.134^{***}	1.000		
Firm size	-0.550^{***}	0.257^{***}	-0.245^{***}	0.269^{***}	-0.160^{***}	0.029^{**}	0.029^{**}	-0.037^{***}	0.058^{***}	1.000	
Board independence	0.059^{***}	0.076^{***}	0.086^{***}	0.077^{***}	0.089^{***}	0.003	0.025^{*}	0.031^{**}	0.042^{***}	−0.018	1.000
Board size	-0.306^{***}	0.194^{***}	-0.073^{***}	0.200^{***}	-0.049^{***}	0.057^{***}	0.004	−0.019	0.014	0.531^{***}	0.107^{***}
Staggered board	0.178^{***}	−0.009	0.110^{***}	−0.013	0.080^{***}	0.067^{***}	-0.037^{***}	−0.019	-0.056^{***}	-0.236^{***}	0.048^{***}
CEO duality	-0.171^{***}	0.055^{***}	-0.100^{***}	0.059^{***}	-0.087^{***}	0.110^{***}	−0.013	−0.008	-0.048^{***}	0.308^{***}	0.017
CEO compensation	-0.336^{***}	0.100^{***}	-0.206^{***}	0.108^{***}	-0.174^{***}	0.160^{***}	0.099^{***}	0.113^{***}	-0.099^{***}	0.609^{***}	0.084^{***}
Female CEO	-0.104^{***}	0.059^{***}	0.026^{*}	0.060^{***}	0.030^{**}	−0.010	−0.017	-0.048^{***}	0.002	0.065^{***}	0.040^{***}
Board age diversity	0.082^{***}	-0.027^{*}	0.029^{**}	-0.028^{**}	0.032^{**}	-0.112^{***}	0.109^{***}	-0.029^{**}	0.084^{***}	-0.111^{***}	-0.067^{***}
Board qualifications	−0.024	0.061^{***}	0.035^{**}	0.062^{***}	0.025	0.002	-0.043^{***}	-0.027^{*}	-0.045^{***}	0.054^{***}	−0.003
Board nationality mix	-0.162^{***}	0.034^{**}	-0.059^{***}	0.037^{**}	-0.045^{***}	0.004	0.096^{***}	0.005	-0.085^{***}	0.189^{***}	−0.008
Board gender ratio	0.264^{***}	-0.063^{***}	0.107^{***}	-0.066^{***}	0.075^{***}	−0.001	−0.011	-0.211^{***}	-0.040^{***}	-0.338^{***}	0.152^{***}
Spread	−0.012	0.018	0.008	0.019	0.006	0.008	-0.027^{*}	−0.017	−0.020	0.020	-0.028^{**}
Happen	-0.026^{**}	-0.099^{***}	-0.142^{***}	-0.098^{***}	-0.118^{***}	0.030^{**}	-0.040^{***}	0.078^{***}	-0.119^{***}	0.084^{***}	0.029^{**}
Worried	-0.042^{***}	-0.144^{***}	-0.192^{***}	-0.141^{***}	-0.164^{***}	0.032^{**}	-0.053^{***}	0.085^{***}	-0.079^{***}	0.095^{***}	−0.007
Harm	-0.031^{**}	-0.116^{***}	-0.165^{***}	-0.114^{***}	-0.144^{***}	0.018	-0.041^{***}	0.082^{***}	-0.090^{***}	0.097^{***}	0.019

(Continues)

TABLE 3 (Continued)

	Board size	Staggered board	CEO duality	CEO compen-sation	Female CEO	Board age diversity	Board qualifica-tions	Board national-ity mix	Board gender ratio	Spread	Happen	Worried
Board size	1.000											
Staggered board	−0.018	1.000										
CEO duality	0.229***	0.008	1.000									
CEO compen-sation	0.316***	−0.185***	0.289***	1.000								
Female CEO	0.028**	0.001	0.003	0.039***	1.000							
Board age diversity	−0.175***	−0.164***	−0.169***	−0.046***	−0.075***	1.000						
Board qualifi-cations	0.076***	−0.011	0.029*	0.053***	0.010	0.039**	1.000					
Board nationality mix	0.109***	−0.040**	0.022	0.171***	0.035**	0.056***	−0.013	1.000				
Board gender ratio	−0.213***	0.180***	−0.007	−0.224***	−0.119***	0.125***	0.048***	−0.010	1.000			
Spread	−0.057***	−0.018	0.002	−0.034**	−0.007	0.060***	0.001	−0.014	0.028**	1.000		
Happen	0.005	0.014	0.029**	0.084***	0.060***	0.021	0.005	0.049***	−0.024*	0.001	1.000	
Worried	−0.034**	−0.025*	0.015	0.090***	0.045***	0.032**	−0.018	0.040**	−0.037***	−0.005	0.895***	1.000
Harm	−0.012	−0.024*	0.032**	0.105***	0.066***	0.003	0.009	0.040**	−0.002	−0.008	0.865***	0.936***

Note: This table reports Spearman correlation coefficients among the main variables of interest.
*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

TABLE 4 Chemical emissions effect on corporate reputational exposure rating.

Dep var: Reputational Exposure Rating	**(1)**	**(2)**	**(3)**
Chemical Emissions/Total Assets	−0.01862***		
	[0.0008]		
Chemical Emissions/Net Income		−0.01992***	
		[0.0003]	
Chemical Emissions/Total Sales			−0.01147**
			[0.0403]
ROA	0.5494**	0.5582**	0.5204**
	[0.0292]	[0.0268]	[0.0387]
Leverage	0.6433***	0.6434***	0.6128***
	[0.0000]	[0.0000]	[0.0000]
Tobin's *Q*	−0.1349***	−0.1356***	−0.1288***
	[0.0000]	[0.0000]	[0.0000]
Tangibility	−0.08512	−0.07770	−0.1036
	[0.2804]	[0.3237]	[0.1990]
Firm size	−0.4730***	−0.4532***	−0.4675***
	[0.0000]	[0.0000]	[0.0000]
Observations	5159	5159	5140
Year dummies	Yes	Yes	Yes
Pseudo *R*-sq.	0.1181	0.1182	0.1170

Note: Ordered probit results from Equation (1). The dependent variable is Reputational Exposure Rating. Columns 1–3 report results when the key independent variables are Chemical Emissions/Total Assets, Chemical Emissions/Net Income and Chemical Emissions/Total Sales, respectively. Robust standard errors are reported in parentheses.
*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

exceeds the median value of the sample, and 0 otherwise. We regress *Reputational Exposure Rating* on the variable *Happen* and the interaction between *Chemical Emissions/Total Assets* and *Happen*, and present the results in Table 6. Given the differences in climate change beliefs across states, we cluster the standard errors at the state level. The coefficient on the interaction term is significantly negative, indicating that companies operating in states with higher levels of concern about climate change tend to experience a stronger correlation between their emissions and reputational exposure. Our findings remain robust when using measures based on alternative survey questions, *Worried* (an indicator that takes a value of 1 if the fraction of respondents in the state who answer 'yes' to the question of whether they are worried about global warming exceeds the median value of the sample, and 0 otherwise) and *Harm* (a dummy variable that takes a value of 1 if the percentage of respondents in the state who answer 'yes' to the question of whether they think global warming will harm people in the United States a moderate amount/a great deal exceeds the median value of the sample, and 0 otherwise).

4.4 | Robustness tests

This subsection addresses potential endogeneity issues related to reverse causality and measurement errors. Reverse causality could affect the results of our analysis if firms with a bad reputation pursue an environmental strategy (e.g. decreasing their chemical emissions) to enhance credibility and their reputation (Hult et al., 2018; Ulke & Schons,

TABLE 5 Chemical emissions effect and corporate governance.

Dep var: Reputational exposure rating	(1)	(2)	(3)	(4)	(5)	(6)
Chemical Emissions/Total Assets	−0.1111***	−0.1549***	−0.2430***	−0.01348**	−0.03830***	−0.01926***
	[0.0043]	[0.0018]	[0.0000]	[0.0341]	[0.0000]	[0.0000]
Board independence	0.002917					
	[0.1022]					
Chemical Emissions/Total Assets × Independence	0.001108**					
	[0.0181]					
Board size		−0.2161**				
		[0.0428]				
Chemical Emissions/Total Assets × Board size		0.05965***				
		[0.0059]				
CEO compensation			−0.05165			
			[0.1081]			
Chemical Emissions/Total Assets × CEO compensation			0.02613***			
			[0.0001]			
Staggered board				0.2176***		
				[0.0000]		
Chemical Emissions/Total Assets × Staggered board				−0.02518**		
				[0.0167]		
CEO duality					−0.1280***	
					[0.0029]	
Chemical Emissions/Total Assets × CEO duality					0.04679***	
					[0.0000]	
Female CEO						−0.5608***
						[0.0000]
Chemical Emissions/Total Assets × Female CEO						0.07503***
						[0.0032]
ROA	0.5635**	0.5302**	0.5464**	0.5036**	0.5243**	0.5620**
	[0.0245]	[0.0352]	[0.0312]	[0.0470]	[0.0380]	[0.0259]
Leverage	0.6327***	0.6431***	0.6420***	0.6566***	0.6315***	0.6417***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Tobin's *Q*	−0.1419***	−0.1311***	−0.1329***	−0.1375***	−0.1302***	−0.1384***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Tangibility	−0.1023	−0.07774	−0.08717	−0.07479	−0.07156	−0.09729
	[0.1953]	[0.3239]	[0.2738]	[0.3435]	[0.3659]	[0.2182]

(Continues)

TABLE 5 (Continued)

Dep var: Reputational exposure rating	(1)	(2)	(3)	(4)	(5)	(6)
Firm size	−0.4756***	−0.4681***	−0.4792***	−0.4644***	−0.4759***	−0.4503***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Observations	5,159	5,159	5,159	5,159	5,159	5,159
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo *R*-sq.	0.1193	0.1187	0.1192	0.1195	0.1197	0.1197

Note: This table presents regression results testing the role of corporate governance in the relationship between toxic chemical emissions (Chemical Emissions/Total Assets) and Reputational Exposure Rating. The dependent variable is Reputational Exposure Rating. Robust standard errors are reported in parentheses.
*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

TABLE 6 Chemical emissions effect and climate change beliefs.

Dep var: Reputational Exposure Rating	(1)	(2)	(3)
Chemical Emissions/Total Assets	−0.01950***	−0.01225*	−0.01496**
	[0.0006]	[0.0652]	[0.0226]
Chemical Emissions/Total Assets × Happen	−0.005409**		
	[0.0313]		
Chemical Emissions/Total Assets × Worried		−0.01537**	
		[0.0272]	
Chemical Emissions/Total Assets × Harm			−0.01079*
			[0.0612]
ROA	0.4931*	0.4952*	0.5025**
	[0.0526]	[0.0519]	[0.0484]
Leverage	0.6390***	0.6444***	0.6468***
	[0.0000]	[0.0000]	[0.0000]
Tobin's *Q*	−0.1372***	−0.1372***	−0.1379***
	[0.0000]	[0.0000]	[0.0000]
Tangibility	−0.07164	−0.07255	−0.07315
	[0.3640]	[0.3575]	[0.3537]
Firm size	−0.4720***	−0.4757***	−0.4758***
	[0.0000]	[0.0000]	[0.0000]
Observations	5,159	5,159	5,159
Year dummies	Yes	Yes	Yes
Pseudo *R*-sq.	0.1183	0.1184	0.1184

Note: This table presents ordered probit results for the sample for the period 2007–2019. The dependent variable is Reputational Exposure Rating. Robust standard errors are reported in parentheses.
*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

2016). To address this issue, we make use of the two-stage least squares method (2SLS). In addition, measurement errors could lead to inconsistent estimates of the association between corporate pollution and reputational exposure. Following Cui et al. (2018), we adopt an alternative measure for reputational exposure, namely the Reputational Exposure Index to alleviate this concern.

To address potential reverse causality, we adopt two additional variables as instruments for *Chemical Emissions/Total Assets* that are likely to fulfil both the relevance and exclusion requirements. Specifically, we use lagged median *Chemical Emissions/Total Assets* for all firms situated within the counties where the polluting facilities of the focal company are located (referred to as *County_CE*), and lagged industry-median *CE* (referred to as *Industry_CE*). Geographic location is employed to capture the influence of endogenous variables in earlier research (e.g. Jiraporn et al., 2014; Lin et al., 2016), primarily due to its fixed nature and its potential to be exogenous. Also, prior research indicates that corporate environmental performance can vary considerably among industries, which can be attributed to various aspects like product types, business and regulatory environment, changes in social norms and specific challenges that emerge within a given social context (see, e.g. McWilliams & Siegel, 2000; Waddock & Graves, 1997). Thus, we anticipate firm-level *Chemical Emissions/Total Assets* to be closely associated with the focal company's industry norm, as represented by its industry-median *Chemical Emissions/Total Assets*. Besides, it is not apparent why the industry-median *Chemical Emissions/Total Assets* is connected to the reputational exposure of an individual company. Indeed, the reputational exposure rating is determined by media coverage of a specific firm's negative events, not by the typical performance of the industry in which the company operates.

In Table 7, models (1) and (3) show the results of the first-stage regressions. The coefficients on *County_CE* and *Industry_CE* are statistically significant and satisfy the relevance criterion. The coefficient of our main variable of interest preserves its significance and direction when we apply the instrumental variables method to the estimation, and has a greater magnitude than in our main specification, −0.01913 and −0.03330, respectively.

To further ensure the robustness of our findings, we explore an alternative metric to gauge corporate reputational exposure. We follow the popular practice in the existing literature (Becchetti & Manfredonia, 2022; and Cui et al., 2018) and adopt the Reputational Exposure Index as an alternative measure of reputational exposure rating. Reputational Exposure Index dynamically captures and quantifies reputational exposure related to ESG incidents and varies from 0 (lowest) to 100 (highest). The calculation of a company's Reputational Exposure Index is based on multiple factors such as the influence of information sources, the timing and frequency of such information, and the content of the information itself, including the degree of severity (harshness) and novelty (newness) associated with the incidents. To make the signs of regression results comparable to our baseline model, we multiply the Reputational Exposure Index by minus one. The results are shown in Table 8, which illustrate that the coefficients of the three chemical emissions measures (*Chemical Emissions/Total Assets*, *Chemical Emissions/Net Income* and *Chemical Emissions/Total Sales*) remain negative and statistically significant in all specifications. These findings suggest that there exists a negative connection between corporate pollution and reputational exposure rating, which still holds when utilizing the Reputational Exposure Index measure. Furthermore, given that our key variable of interest is the corporate toxic chemical emissions intensity, one may argue that the dependent variable may be affected by other factors that are not captured by chemical emissions, leading to an omitted variable bias. We include the Social and Governance Scores collected from Refinitiv as additional controls. The coefficients of the Social and Governance Scores are significant and negative in some cases. Nonetheless, the main variables of interest remain intact in both significance and direction. The results are not reported due to space constraints but are accessible upon request.

4.5 | Extensions

In this subsection, we investigate how information asymmetry and the ratification of the Paris Agreement affect the relationship between corporate chemical emissions and reputational exposure. Specifically, we add the variable *Mod* and one interaction term *Chemical Emissions/Total Assets* × *Mod* to baseline Equation (1). The regression function is

TABLE 7 Chemical emissions effect: Two-stage least squares regressions.

Dep var:	First stage Chemical Emissions/Total Assets (1)	Second stage Reputational Exposure Rating (2)	First stage Chemical Emissions/Total Assets (3)	Second stage Reputational Exposure Rating (4)
County_CE	0.8855***			
	[0.0000]			
Industry_CE			0.7656***	
			[0.0000]	
Chemical Emissions/Total Assets		−0.01913**		−0.03330***
		[0.0108]		[0.0060]
ROA	0.8566**	0.9148***	1.3785**	0.9531***
	[0.0385]	[0.0003]	[0.0133]	[0.0002]
Leverage	0.6145***	0.9893***	0.5922**	1.0056***
	[0.0006]	[0.0000]	[0.0146]	[0.0000]
Tobin's *Q*	−0.1652***	−0.1614***	−0.4919***	−0.1693***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Tangibility	1.9133***	0.04264	2.3274***	0.1221
	[0.0000]	[0.6390]	[0.0000]	[0.2469]
Firm size	−0.1708***	−0.5516***	−0.4440***	−0.5583***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Constant	1.1898***	12.837***	3.9875***	12.915***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Observations	5159	5159	5159	5159
Year dummies	Yes	Yes	Yes	Yes
Pseudo *R*-sq.	0.6554	0.3207	0.3771	0.3191

Note: This table presents two-stage least squares estimations using instrumental variables to explain the dependent variable, Chemical Emissions/Total Assets. In the first stage, we use the median value of Chemical Emissions/Total Assets, either for firms in the counties where the focal firm's polluting facilities operate (*County_CE*) or for firms in the same industry as the focal firm (*Industry_CE*), as instrumental variables. We report the results in columns (1) and (3), respectively. In the second stage, we use the fitted value of the dependent variable, Chemical Emissions/Total Assets, from the first stage to estimate the relation to *Reputational Exposure Rating*. The results are presented in columns (2) and (4), respectively. Robust standard errors are reported in parentheses.

*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

expressed as

$$\{Reputational\ Exposure\ Rating\}_{i,t} = \alpha_0\{Chemical\ Emissions/Total\ Assets\}_{i,t-1} + \alpha_1\{Chemical\ Emissions/Total\ Assets\}_{i,t-1} \times \{Mod\}_{i,t-1} + \alpha_2\{Mod\}_{i,t-1} + \sum_{k=1}^{k} \beta_k X_{i,t-1} + \gamma_t + \epsilon_{i,t} \quad (4)$$

where $\{Mod\}_{i,t-1}$ represents information asymmetry (*Spread*) or the Paris Agreement indicator (*Paris Agreement*).

TABLE 8 Alternative reputational exposure measure.

Dep var: Reputational Exposure Index	**(1)**	**(2)**	**(3)**
Chemical Emissions/Total Assets	−0.03434***		
	[0.0000]		
Chemical Emissions/Net Income		−0.03543***	
		[0.0000]	
Chemical Emissions/Total Sales			−0.02563***
			[0.0000]
ROA	0.7194***	0.7327***	0.6715***
	[0.0056]	[0.0048]	[0.0097]
Leverage	0.5252***	0.5236***	0.5008***
	[0.0000]	[0.0000]	[0.0000]
Tobin's *Q*	−0.1827***	−0.1834***	−0.1752***
	[0.0000]	[0.0000]	[0.0000]
Tangibility	−0.2462***	−0.2401***	−0.2601***
	[0.0012]	[0.0015]	[0.0008]
Firm size	−0.5746***	−0.5388***	−0.5657***
	[0.0000]	[0.0000]	[0.0000]
Observations	5159	5159	5140
Firm dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
R-sq.	0.08145	0.08154	0.08048

Note: This table presents OLS regression results for the sample for the period 2007–2019. The dependent variable is Reputational Exposure Index. Robust standard errors are reported in parentheses.
*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

4.5.1 | Effects of chemical emissions and information asymmetry

Corporate reputation is shaped by the attitudes and beliefs that its stakeholders hold based on the information they have regarding the firm's past, current and anticipated future performance (Cui et al., 2018). A high extent of information asymmetry can result in a lack of transparency and understanding, which would lead to public concerns and distrust, and may exacerbate the adverse impact of corporate pollution on the company's reputational exposure rating. To investigate the effect of information asymmetry on the connection between chemical emissions and reputational exposure rating, we include a variable for information asymmetry and an interaction term to represent the interactive effect.

We adopt bid–ask spread as the measure of information asymmetry, following the practice of Cho et al. (2013) and Cui et al. (2018). Although bid–ask spreads may not offer a precise measurement of information asymmetry, larger spreads indicate lower levels of liquidity, which are indicative of the adverse selection issues that uninformed investors may face (Bushee et al., 2010; Glosten & Milgrom, 1985; Leuz & Verrecchia, 2000). Table 9 displays the regression results of *Reputational Exposure Rating* on the 1-year lags of chemical emissions (*Chemical Emissions/Total Assets*) and information asymmetry (*Spread*), and the interaction term between the two (*Chemical Emissions/Total Assets* × *Spread*). According to our analysis, the estimated coefficients on both *Chemical Emissions/Total Assets* and *Chemical Emissions/Total Assets* × *Spread* are negative, indicating that the interaction of chemical emissions and information

TABLE 9 Information asymmetry.

Dep var: Reputational Exposure Rating	**(1)**
Chemical Emissions/Total Assets	−0.01725***
	[0.0020]
Spread	0.2276***
	[0.0001]
Chemical Emissions/Total Assets × Spread	−0.05537***
	[0.0001]
ROA	0.5459**
	[0.0303]
Leverage	0.6521***
	[0.0000]
Tobin's *Q*	−0.1336***
	[0.0000]
Tangibility	−0.08314
	[0.2921]
Firm size	−0.4727***
	[0.0000]
Observations	5159
Year dummies	Yes
Pseudo *R*-sq.	0.1184

Note: This table presents ordered probit results for the sample for the period 2007–2019. The dependent variable is Reputational Exposure Rating. Robust standard errors are reported in parentheses.
*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

asymmetry, or chemical emissions by firms with high information asymmetry, leading to a greater reduction in reputational exposure rating. To put it differently, information asymmetry has a positive moderating effect on the link between chemical emissions and reputational exposure rating. One possible rationale for this observation is that companies with higher levels of information asymmetry are often linked with greater uncertainty, which may lead to increased public mistrust. As a result, the community may become more sceptical of these firms, ultimately resulting in a greater penalty for chemical emissions in the form of a detrimental impact on their reputation.

4.5.2 | Effects of the Paris Agreement

The ratification of the Paris Agreement in December 2015 drew considerable public focus towards the issue of climate change and the detrimental effects of corporate pollution. Almost all governments have signed up to the Paris Agreement, pledging to cut emissions and committing to publish 5-yearly plans for how they will do so. Regardless of the varying degrees of implementation, the Paris Agreement constitutes an international standard for firm action that cannot be ignored. Although there is debate about the balance between the risks and opportunities that the Paris Agreement creates for firms, we expect that the ratification of the agreement increases public awareness of chemical emissions, which should impact corporate reputational exposure rating. We incorporate an indicator variable for the *Paris Agreement*, which equals 1 for years after 2015, and 0 otherwise, and construct the interaction term *Chemical*

TABLE 10 The Paris Agreement.

Dep Var: Reputational Exposure Rating	(1)	(2)
Chemical Emissions/Total Assets	−0.01862***	−0.02092***
	[0.0008]	[0.0017]
Paris Agreement	−0.1483**	−0.1669**
	[0.0487]	[0.0411]
Chemical Emissions/Total Assets × Paris Agreement		0.006957
		[0.4850]
ROA	0.5495**	0.5452**
	[0.0292]	[0.0305]
Leverage	0.6434***	0.6443***
	[0.0000]	[0.0000]
Tobin's *Q*	−0.1349***	−0.1345***
	[0.0000]	[0.0000]
Tangibility	−0.08516	−0.08720
	[0.2801]	[0.2682]
Firm size	−0.4730***	−0.4724***
	[0.0000]	[0.0000]
Observations	5,159	5,159
Pseudo *R*-sq.	0.1181	0.1181

Note: This table presents ordered probit results for the sample for the period 2007–2019. The dependent variable is Reputational Exposure Rating. Robust standard errors are reported in parentheses.
*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

Emissions/Total Assets × Paris Agreement. The year-fixed effect is removed in this specification. We expect that the coefficients for both *Paris Agreement* variable and the interaction term are negative. According to the regression finding presented in Table 10, the company's reputational exposure rating decreased following the ratification of the agreement. This result aligns with our expectation of a negative coefficient on the *Paris Agreement* indicator. Nevertheless, the coefficient of the interaction term lacks statistical significance. Therefore, there is no evidence that ratification of the Paris Agreement exacerbates the impact of firm emissions on reputational exposure rating.

5 | CONCLUSIONS

Facing rapid and intensive climate change, an ever-increasing number of corporations are committing to incorporate social and environmental considerations into their business practices. This paper asks whether and to what extent the public punishes (rewards) polluting (environmentally responsible) firms with respect to their reputation. Whereas the existing literature considers broad aspects of ESG performance, our focus is specifically on corporate environmental performance, examining the impact of chemical emissions on reputational exposure rating. Moreover, to account for the potential agency risk associated with corporate governance, we study how the weak governance structure and demographic background of top management team mitigate or exacerbate the emissions–reputation relationship. Furthermore, our research investigates the impact of corporate pollution on its reputation when the company is releasing chemicals that contribute to climate change and is situated in a region where there is high level of public concern about climate change. We examine whether the heightened public scrutiny in such areas amplifies the adverse impact of chemical emissions on the firm's reputation.

To test these hypotheses, we collect data from the TRI of the U.S. EPA and examine how chemical emissions affect reputational exposure. Our sample includes 5978 observations from 745 individual firms between 2007 and 2019. We produce evidence showing that higher-polluting firms have greater reputational exposure. This effect is robust across a variety of firm-specific control variables, and econometric techniques that alleviate potential endogeneity bias. In addition, we explore the characteristics of corporate governance and discover that both the structure of corporate governance and the demographic background of the top management team are critical in channelling the effects of pollution on corporate reputation. We then investigate the moderating effect of community climate change beliefs and determine that the adverse effect of corporate pollution on reputational exposure rating is heightened in regions where local residents hold stronger beliefs in climate change. We further demonstrate that the relationship between firm pollution level and reputational exposure is more pronounced for companies with higher information asymmetry, which highlights the significance of communication with the public to enhance information transparency between insiders and outsiders, ultimately boosting the firm's credibility. Additionally, firms' reputational exposure ratings declined after the ratification of the Paris Agreement, although we do not observe that the effect of firm pollution level on reputational exposure becomes stronger.

Taken together, our results highlight some specific channels that firms may focus on to improve environmental management and decrease their reputational exposure. Decreasing environmental emissions is crucial for obvious reason related to climate change, but is also important for improving firms' reputational image. Our findings suggest that firms can potentially enjoy reputational gains by focusing on their institutional design. Specifically, improving their corporate governance structure and top management profile can beneficially impact the emissions–reputation relationship.

In terms of policy implications, our paper documents that environmental regulations and policies can have a complementary role in firms' emissions strategies. This effect may manifest explicitly, because failure to curb pollutant emissions may result in higher penalties that trigger reputational loses, or implicitly, by setting standards for what the public would consider responsible environmental behaviour. Several potential extensions of this study could be pursued by future research, including consideration of different samples and use of survey data in which executives reveal their perspectives and strategic choices in response to firm reputation and environmental impacts.

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ENDNOTES

[1] Cumulatively since 1850, the United States has contributed a greater proportion of the greenhouse gases responsible for the present-day climate change than any other country, including some 20% of total global carbon dioxide emissions.

[2] A reputational exposure rating evaluates a firm's ESG-related risk exposure based on risk incidents that are reported specifically about the corporations, as well as ESG risk linked to the firm's sector, headquarters' location and states where the firm has been exposed to ESG risk incidents. Reputational exposure rating ranges from AAA to D, and we convert this categorical variable into a numeric scale from 1 to 10, where AAA = 10 and $D = 1$. A higher numeric value represents a better Reputational Exposure Rating.

[3] Earlier studies investigating environmental performance have typically used data on ratings from third-party assessments, for example, KLD (now MSCI ESG STATS) (Attig et al., 2013), or environmental performance data from Trucost (Bolton & Kacperczyk, 2021).

[4] We obtain almost identical results when replacing Chemical Emissions/Total Assets with CO_2 emissions as the variable of interest.

[5] The TRI is a database that provides information on the release of toxic chemicals and efforts to prevent pollution by industrial and federal facilities. Release of a chemical refers to emitting it into the air or water or disposing of it on land. Facilities in various industries in the United States are required to annually report the amount of each chemical they release into the environment or manage through methods such as recycling, energy recovery or treatment.

[6] Although our main specification scales chemical emissions by firm size, our analysis using the simple level of emissions per firm yields similar results.

[7] We achieve similar findings utilising survey data from 2016 and 2018.

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APPENDIX A: VARIABLE DEFINITIONS

Variable group	Definition	Data source
A. Dependent variable		
Reputational Exposure Rating	Reputational Exposure Rating reflects: (i) a company's own ESG-related risk exposure due to risk incidents reported specifically about the company, and (ii) the ESG risk associated with the sector and location of the company's headquarters and states where the company has been exposed to ESG risk incidents. The variable takes a value from 1 to 10, where $D = 1$ and AAA = 10. Higher values indicate a better reputational rating.	WRDS
Reputational Exposure Index	Reputational Exposure Index dynamically captures and quantifies reputational exposure related to ESG incidents and ranges from zero (lowest) to 100 (highest).	WRDS
B. Explanatory variables		
Chemical Emissions	Sum of total air, water and ground on-site and off-site toxic chemical emissions	TRI (EPA)
Chemical Emissions/Total Assets	The ratio of the total amount of toxic chemicals emitted to the total assets of a firm	TRI & Compustat
Chemical Emissions/Net Income	The ratio of the total amount of toxic chemicals emitted to the total net income of a firm	TRI & Compustat
Chemical Emissions/Total Sales	The ratio of the total amount of toxic chemicals emitted to the total sales of a firm	TRI & Compustat
C. Firm characteristics		
ROA	Ratio of earnings before interest, taxes, depreciation and amortization (EBITDA) to total assets	Compustat

(Continues)

Variable group	Definition	Data source
Leverage	Ratio of long-term debt plus debt in current liabilities to total assets	Compustat
Tobin's *Q*	Market value divided by replacement costs	Compustat
Tangibility	Ratio of net property, plant and equipment to total assets	Compustat
Firm size	Natural logarithm of total assets in US$ millions	Compustat
D. Corporate governance		
Board independence	Percentage of independent board members	ISS (formerly RiskMetrics)
Board size	Natural logarithm of the total number of board members at the end of the fiscal year	ISS (formerly RiskMetrics)
Staggered board	Indicator equals 1 for a board in which directors are divided into separate classes (typically three) with each class being elected to overlapping terms	ISS (formerly RiskMetrics)
CEO duality	Indicator equal to 1 when the CEO is also chairman of the board	Execucomp
CEO compensation	Natural logarithm of the CEO's total compensation	Execucomp
Female CEO	Dummy variable equals 1 if the CEO is female, and 0 otherwise	Execucomp
Board age diversity	Standard deviation of the ages of directors	Boardex
Board qualifications	Standard deviation of the total number of qualifications of directors	Boardex
Board nationality mix	Proportion of directors from different countries	Boardex
Board gender ratio	Proportion of male directors	Boardex
F. Information asymmetry		
Spread	Annual average of daily bid–ask spread (simple difference between quoted bid and ask prices)	CRSP
G. Climate change belief		
Happen	Indicator equals 1 if the proportion of individuals in the state who answered 'yes' to the question of whether they believe that climate change is happening is above the sample's median, and 0 otherwise	Climate Opinion Map
Worried	Indicator equals 1 if the proportion of individuals in the state who answered 'yes' to the question of whether they are worried about global warming is above the sample's median, and 0 otherwise	Climate Opinion Map

(Continues)

Variable group	Definition	Data source
Harm	Indicator equals 1 if the proportion of individuals in the state who answered ‘yes’ to the question of whether they think global warming will harm people in the United States a moderate amount/a great deal is above the sample’s median, and 0 otherwise	Climate Opinion Map

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