

Real Effects of Personal Liability: Evidence from Industrial Pollution

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Abstract

This paper provides evidence that holding executives and directors personally liable for environmental corporate misconduct has a significant economic impact. Using the variation in legal systems across Canada and exploiting a court case where personal liability for environmental violations was enforced, I find that personal liability leads companies to reduce pollution. I show that it is associated with a decline in stock return performance, highlighting a cost for shareholders. Overall, this paper presents evidence of both the benefits and costs of enforcing personal liability for corporate environmental externalities.

Keywords: Personal Liability, Corporate Governance, Pollution, Insurance

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1 Introduction

Corporate environmental impact has evolved in recent years from being merely an externality that corporations may choose to address, to being recognized as a major source of business and financial risk that corporations *must* disclose and manage. As a consequence, the nature of directors' and executives' corporate and fiduciary duties is changing (Wallace, 2008, Barker et al., 2021, Ortega, 2023). Environmental-related lawsuits against them personally have begun to appear and are expected to increase.¹ Moreover, given the urgency of addressing climate change, personal accountability appears to be an effective deterrent against corporate environmental misconduct (Scruton, 2012, Garrett, 2014, Admati, 2017).²

However, personal liability remains scarcely studied, and its effects on corporate (environmental) outcomes are still unknown. Limited personal liability is a key feature of corporations which are defined by the legal separation between the entity itself and its decision-makers.³ Limited exposure to personal liability for corporate decisions ensures that the most qualified individuals are hired as executives and directors, and that they take the optimal amount of risk for business growth (Romano, 1989, Black et al., 2006). However, it also creates a moral hazard, as decision-makers do not fully internalize the costs of their decisions, which are borne by the corporation and society. Historically, corporate executives and directors have been shielded from personal liability through weak law enforcement, corporate indemnity, and Director & Officer (D&O) liability insurance (Black et al., 2005, Black et al., 2006, Henning, 2016). Therefore, there have been very few opportunities to study the benefits and costs of personal liability for di-

¹For instance, Shell's directors were personally sued in England in 2023 over the climate strategy they implemented for the corporation. Moreover, PG&E executives were sued for negligence following the wildfires in 2022. See <https://www.theguardian.com/environment/2023/feb/09/shell-directors-personally-sued-over-flawed-climate-strategy> and <https://apnews.com/article/wildfires-business-fires-lawsuits-california-450c961a4c6b467fcfb5465e7b9c5ae7>

²Personal accountability is feasible when the underlying actions are legislated. However, many climate-related issues remain outside the scope of current laws, and therefore are not deemed illegal. As environmental legislation continues to evolve, it is expected that the scope of corporate actions affecting climate that are considered illegal will expand significantly.

³This is the legal concept of separate legal personality. For instance, see Halpern et al., 1980, Gelderblom et al., 2013, Dari-Mattiacci et al., 2017 for a history of this concept within the corporate structure and the emergence of personal liability.

rectors and executives. In this paper, I provide an empirical setting for examining this trade-off. Specifically, I study the effects of imposing personal liability for environmental misconduct on corporate pollution and its impact on firm value.

My empirical setting is based on a court case that occurred in the province of Ontario (Canada), *Baker et al. v. Director, Ministry of the Environment* (Northstar), where *out-of-pocket* personal liability was enforced for the first time in response to corporate pollution. Although the provision for personal liability under environmental law had been legislated in Ontario for decades, the Northstar case was the first where it was enforced by the environmental regulator and the Ontario courts while the corporation was under bankruptcy protection, hence shielded from environmental liability.⁴ Additionally, the directors and executives did not have liability insurance for pollution claims. I use this court case as a shock to the *perception* of personal liability risk for corporate environmental violations in a difference-in-differences setting. I exploit the fact that the Northstar case did not reach the Supreme Court, thus influencing provinces differently. In particular, Ontario operates under a common law system, where court cases have precedential value and influence future decisions within the province and, to some extent, in other common law provinces. Quebec, Ontario's neighboring province, operates under a civil law system and is therefore not affected by court cases that do not reach the Supreme Court. Hence, I use facilities that are located in Ontario as the treated group and facilities that are located in Quebec as the control group.

I use company-level D&O liability insurance data which is available for publicly listed firms in Canada.⁵ I validate that the Northstar case indeed altered the perception of personal liability risk by examining its effect on D&O liability insurance coverage. Second, I use facility-pollutant-level pollution data from the National Pollutant Release Inventory (NPRI) to study the effect of Northstar on corporate pollution. Third, I use company-

⁴The Northstar case (2013) follows the Abitibowater case (2012), wherein the Supreme Court of Canada (SCC) established that secured creditors take precedence in receiving claims over pollution cleanup claims held by provincial Ministries of Environment. This ruling was subsequently overturned by the SCC in 2019 with the Redwater case.

⁵In addition to providing a case of out-of-pocket personal liability enforcement, a key advantage of studying personal liability in the Canadian context is the availability of D&O liability insurance data. Listed companies in Canada are required to disclose this information, unlike in the U.S.

level board data from BoardEx to study the effect of Northstar on board composition. Last, I use company-level stock price data from Compustat to analyze the effect of Northstar on firm value.

First, I show that (public) companies in Ontario increased their D&O liability insurance total coverage and coverage per director relative to their counterparts in Quebec following the Northstar case. This result validates Northstar as a shift in the perception of personal liability enforcement, a change that previous studies on personal liability (Naaraayanan et al., 2021, Ivanova et al., 2022) which focused on legislative changes and lacked access to D&O liability insurance data could not capture.

In the baseline results, I show that facilities operating in Ontario reduced pollution by an average of 23% within facilities and controlling for trends at the industry and pollutant level, relative to facilities in Quebec following the Northstar settlement. The result remains significant and economically meaningful when including company-year fixed effects, which allows for the comparison of pollution in facilities in Ontario and Quebec that belong to the same firm and absorbs unobserved time-variant differences across companies. Investigating margins of response, I find that facilities reduced pollution in the intensive margin which suggests that they invested to make their production processes cleaner. In addition, I find that the response in pollution reduction is stronger for facilities belonging to financially healthy companies, suggesting that constrained firms are not the ones reacting the most.

Next, I examine the effects of the Northstar case on board composition and size. I find that the number of environmental expert directors decreases by 19% to 32%, and their representation on boards declines by 13% to 26% after Northstar, possibly because these directors could be the most at risk of personal liability in the event of environmental violations. Their responsibility includes overseeing the company's environmental policy, disclosure and ensuring regulatory compliance. Additionally, I find that overall board size decreases following the Northstar case, although the estimates are not statistically different from zero.

Finally, I examine the effect of the Northstar case on firms' market performance. I find

that, among companies in Ontario, those in the equipment manufacturing industry (the same industry Northstar belonged to) underperformed the market (based on the Toronto Composite Index) by an average of 2% in the five business days following the Northstar settlement, relative to companies in other industries. This underperformance suggests the market sees enforcement of out-of-pocket personal liability as a cost that drives companies away from their optimal decisions. I show that this effect is stronger for firms with lower market capitalization. This result highlights the trade-off of enforcing personal liability: while reducing pollution benefits society, it comes at a cost to shareholders through a loss in firm value.

This paper contributes to the literature on personal liability of corporate decision makers. Coase, 1960 and Kornhauser, 1982 have determined under which conditions personal liability should matter. Black et al., 2005 and Klausner, 2009 show that personal liability is historically rare. Lin et al., 2019 study the introduction of an out-of-pocket payment of D&O liability insurance deductible. Ding et al., 2022 study changes in perception of personal liability risk following peer directors' personal fines. Donelson et al., 2019, Koudijs et al., 2020, Koudijs et al., 2021, Naaraayanan et al., 2021, Ivanova et al., 2022 study changes in legal personal liability. Brook et al., 1994, Bradley et al., 2011, Aguir et al., 2014, Aguir et al., 2020 study liability of directors as stated in companies' charters. Boyer et al., 2012, Lin et al., 2013 and Boyer et al., 2015 study variations in D&O liability insurance. These papers show the impact of personal liability on governance structures, risk-taking and firm value. The key contribution of this paper is to study the impacts of personal liability on real outcomes, and the costs associated to it. Moreover, I rely on *enforcement* of personal liability rather than changes in legislation or heterogeneity in charters.

Second, this paper contributes to the literature that studies how different corporate liability regimes affect pollution decisions. Alberini et al., 2002 examine the effects of strict liability at the corporate level on pollution. Akey et al., 2021 study the effects of liability of parent companies on subsidiaries' pollution. Bellon, 2021 and Ohlrogge, 2022 investigate the effects of creditors' environmental liability and Bellon, 2022 explores

the effects of target firms' liability on pollution. Chen, 2022 studies land purchasers' environmental liability. Boomhower, 2019 examines the impact of insurance requirements on pollution and industrial organization. This paper focuses on personal liability of directors and executives and how it affects corporate pollution.

The rest of the paper is organized as follows. Institutional background on Canadian environmental law and the importance of the Northstar case are presented in Section 2. Section 3 describes the empirical strategy. Section 4 describes the datasets I use. Section 5 show the results. Section 6 studies the effect on firm performance. Section 7 provides further discussion and Section 8 concludes.

2 Institutional Background

This section provides institutional background on environmental policy in Canada, personal liability under environmental law, and how Director & Officer liability insurance applies to this type of liability. I then describe the Northstar case and its significance as a landmark event.

2.1 Environmental Policy in Canada

2.1.1 Province-level Environmental Legislation

Environmental policy in Canada occurs at different levels and provinces have the most influence. While the federal government determines environmental disclosure (e.g., the NPRI which provides facility-pollutant-level pollution data, used in this study) and sets standard for environmental legislation, it is at the province level that laws are enacted for management of natural resources, restriction on the use of pollutants, disposal of industrial waste. Provinces enforce their environmental legislation within their borders for any party operating in the province, regardless of where corporate headquarters are located or where executives and directors reside. The main enforcement tools provinces use include the issuance of orders to companies for them to comply with the law, the

administration of fines, and prosecution in courts.⁶

One of the main pieces of environmental legislation in Ontario is the Environmental Protection Act (EPA) which was enacted by the provincial government in 1971 at the same time the Ontario Ministry of the Environment was created (the first provincial Ministry of the Environment in Canada). It was written following a decade of severe contamination of the Great Lakes, heavy industrial pollution in the Toronto Don River, and large discharges of mercury in the English-Wabigoon River in Northern Ontario by Dryden Chemicals Ltd.⁷ Facing the same kind of challenges such as mercury contamination of the St Lawrence River, Quebec enacted the Environment Quality Act (EQA) in 1972. Other Canadian provinces enacted their environmental legislation in the 1980s.

2.1.2 Personal Liability Under Environmental Law

The Ontario EPA includes a provision (Section 194) that stipulates that directors and executives may be personally liable for corporate compliance with environmental law according to the *strict* liability approach.⁸ This liability regime means that directors and executives may be held liable on behalf of the company, regardless of their intent or negligence that caused the environmental violation. Rather, it focuses on the fact that the violation occurred and someone needs to pay.⁹ The only defense directors and executives can use under strict liability is proving they exercised proper due diligence to prevent the environmental offense. In practice, those provisions have been rarely used. When they are, corporations usually pay for expenses. Out-of-pocket personal liability for environmental misconduct was enforced in Ontario once before the Northstar

⁶The Ministry of Environment can issue orders to remediate pollution, provide financial funds to pay for future remediation, monitor and report environmental practices, hire pollution experts, etc. In the case of Northstar, the Ministry of Environment issued orders to remediate pollution.

⁷Congress in the U.S. also enacted new pieces of legislation at that time, in particular in reaction to the contamination of Lake Erie. The federal Clean Water Act which aims to control industrial wastewater was strongly amended in 1972 for instance.

⁸EQA in Quebec also includes such provision. In the U.S., such provision is included in CERCLA for instance and discussed in Oswald et al., 1991 and Oswald, 1993.

⁹Precisely, the fundamental concept of strict liability is that merely being or having been in control or management of a facility is sufficient to bear liability for a pollution incident. Courts often examine factors such as who has been a point of contact with the Ministry regarding pollution permits, spill reports, and other relevant matters. This is not the case in corporate law where intent of misconduct needs to be proved. This is sometimes referred to as the "business judgement rule".

case in *R. v. Bata Industries Ltd., Marchant and Weston* (1992).¹⁰ A director and an executive of the Bata Industries company had to pay 12,000 Canadian dollars each and corporate indemnification was forbidden by the Ontario Court. Although this case was the first to enforce out-of-pocket liability in Ontario, the amounts involved were negligible compared to what had to be paid for remediation and the amounts paid later by directors of Northstar Aerospace. The Northstar case was one particular case in which the environmental regulator used the personal liability provision of the EPA to issue an order to pay for full remediation against directors and executives of the company because the latter was shielded from liability.

2.1.3 Director & Officer Liability Insurance for Environmental Violations

Companies commonly purchase D&O liability insurance to protect their directors and executives from legal liability arising from corporate decisions. D&O liability insurance contracts usually cover defense costs and lawsuit settlements for the group of directors and executives of the company.¹¹ They are mainly meant to reimburse indemnification made by the company to the directors and executives. In case corporate indemnification is not feasible because of corporate insolvency, violation of corporate charters or legal prohibition, the insurance pays directly for the directors' and executives' expenses and settlements, unless they are proven guilty.¹²

Most D&O insurance contracts exclude pollution claims. The main reason is that pollution remediation can be very costly as claims may include pollution cleanup, loss of biodiversity, effects on human health, etc. When available, firms can purchase Difference-in-Conditions (DIC) policies which expand their D&O liability insurance to environmental-related claims. The coverage, deductible, premium for pollution claims may be different

¹⁰For an analysis of the case, see <https://prism.ucalgary.ca/server/api/core/bitstreams/08545f90-50e6-43ca-b19e-2fc9e786a119/content>

¹¹Under the Ontario Business Corporations Act (OBCA) and the Canada Business Corporations Act (CBCA), corporations can indemnify their directors and purchase insurance to protect them, provided the indemnification and insurance do not cover liabilities arising from breaches of fiduciary duties or fraudulent conduct.

¹²Precisely, Side A insurance is the one that covers directors and executives when the corporation cannot pay. Insurance companies are usually required to negotiate settlement amounts so that they remain within the insurance coverage limit, ensuring that directors and executives do not pay out-of-pocket. This is known as the "duty to settle."

than other types of claims. Figure A1 in the Appendix provides examples of firms that do have pollution insurance included in their D&O liability insurance policy and have different deductibles for those (Agrium Inc, Wesdome Gold Mine) and firms that specify not having pollution insurance included in their D&O liability insurance (Magna International).

2.1.4 Legal System Heterogeneity in Canada

Different legal systems coexist in Canada. Ontario operates under a common law system while Quebec operates under a civil law system. Figure 1 provides a map of the geography of these two provinces. Courts in Ontario (and in any other provinces) have a *persuasive* authority over courts in other provinces, meaning court decisions in a province may influence court decisions in other provinces.¹³ Because Quebec operates under a civil law system, the persuasive authority of Ontario courts is limited in Quebec, unlike in other provinces.

[INSERT FIGURE 1 HERE]

2.2 Northstar as Landmark

2.2.1 The Northstar Case

Northstar Aerospace Inc. operated a aircraft manufacturing plant in Cambridge, Ontario from 1981 to 2010. They discovered in 2004 that abnormal levels of carcinogens (trichloroethylene and hexavalent chromium) were being released into the properties surrounding their facility. They started remediation of the site in 2004 and filed for bankruptcy protection in 2012 without the site being completely cleaned up. The Ontario Ministry of Environment (MOE) issued an order to the firm in March 2012 to pay for remediation of the polluted site (CAD 15 million) although they were under bankruptcy protection. Since remediation claims were not senior to creditors' claims un-

¹³Only the Supreme Court of Canada has *binding* authority on provincial courts, that is the latter must follow the precedents set by the Supreme Court.

der bankruptcy law, the MOE was left in charge of paying for remediation.¹⁴ In November 2012, the MOE issued an order against the directors personally requesting directors of Northstar to pay for existing remediation annual claims of CAD 1.4 million, as well as a remediation claim of a lump sum of CAD 15 million. The appeal by directors was dismissed. On October 28, 2013, directors reached a settlement with the MOE, paying 4.75 million dollars for the withdrawal of the remediation order against them.¹⁵ The settlement was approved and made public by the Ontario court on the same day.

The enforcement of personal liability by the environmental regulator and Ontario courts came as a surprise for legal experts and companies. The Northstar event was widely reported in the national news and was described as a “wake-up call” for companies and liability insurers.¹⁶ Discussions with an environmental law attorney pointed out: “The Northstar case is a landmark case because the contamination arose from historic industrial operations (as opposed to a major spill incident) and the directors and officers were held liable following the company’s CCAA (bankruptcy) filing. Prior to that, directors and officers were not normally pursued and held liable by the regulator in those situations”. Also, they added that “it impacted all businesses because it meant that directors and officers were at increased risk of having environmental orders issued against them when the company couldn’t fulfill its environmental obligations.”

¹⁴Seniority of creditors’ claims over pollution remediation claims was established right before Northstar in 2012 by the Supreme Court of Canada in the case *Newfoundland and Labrador v. AbitibiBowater Inc.*, 2012 SCC 67. It was later overturned in the *Redwater* case in 2019.

¹⁵This is about a third of the total remediation cost and a significant amount for individual directors. The Annual Information form for 2010 (which is the most recent one that can be accessed on SEDAR) states that “Between 2004 and December 31, 2010, the Company has provided \$22.8 million for estimated environmental testing and remediation costs in respect to environmental issues at the Cambridge, Ontario facility of the Company’s subsidiary Northstar Aerospace (Canada) Inc. (“Northstar Canada”). Of these total costs, Northstar Canada paid \$1.1 million and \$2.2 million for costs incurred in 2010 and 2009, respectively. As of December 31, 2010 and December 31, 2009, the remaining provision for environmental testing and remediation costs was \$7.5 million and \$8.2 million, respectively.” Moreover, the Management Information Circular (also found on SEDAR) for 2010 discloses that directors were paid individually less than US \$100,000 in (before tax) compensation in 2010, which indicates that the settlement was large in comparison of their annual salary.

¹⁶For example, see <https://www.theglobeandmail.com/report-on-business/industry-news/the-law-page/former-northstar-directors-officers-reach-deal-with-ontario-over-cleanup/article15125063/>, <https://www.mccarthy.ca/en/insights/articles/last-directors-standing-expanding-scope-directors-and-officers-environmental-liability-northstar-aerospace-case>, <https://www.canadianunderwriter.ca/risk/wake-call-brokers-placing-liability-1004137900/>

2.2.2 Increase in Enforcement of Personal Liability

I document that Northstar is indeed a landmark case indicative of a shift in the enforcement of personal liability, as evidenced by subsequent orders naming a director and/or executive. First, I hand-collect (publicly available) 84 orders issued by the Ontario MOE to companies between 2009 and 2018. Figure 2 shows that the proportion of environmental orders including directors and/or executives increases over time in Ontario. After 2013, about 70% of the orders name directors and/or executives, whereas 25% to 50% of the orders named directors and/or executives before 2013.¹⁷

[INSERT FIGURE 2 HERE]

Second, using the same sample of 84 environmental orders issued by the MOE, I document the interaction between likelihood of enforcement of personal liability and corporate financial distress. Precisely, I provide evidence comparing the likelihood of directors and executives being personally named in environmental orders for firms described as facing financial distress in the orders, relative to firms that are not described as such. I estimate the following specification

$$1(\text{Individual})_{c,t} = \beta \text{Post}_t \times \text{Financial Distress}_c + \alpha_t + \epsilon_{c,t} \quad (1)$$

where a company c receives an environmental order in year t . $1(\text{Individual})$ is an indicator that equals one if at least one director and/or executive is named in the environmental order. Post is an indicator that equals one for years after 2014. $\text{Financial Distress}$ is an indicator that equals one if the order mentions that the company is facing financial distress or already filed for bankruptcy protection. α_t are year fixed effects and standard errors are robust.

I show in Table A1 in the Appendix that the probability of an order naming a director and/or executive after 2013 increases for companies facing financial distress or under bankruptcy protection compared to those that are not, although the estimates are not statistically different from zero. This finding suggests that the regulator named directors

¹⁷Note that the order naming the Northstar's directors and executives was issued in 2012.

and executives in environmental orders more after 2013, regardless of the financial situation of the company. In other words, directors and executives from all firms faced an increase in the risk of being named in environmental orders following Northstar.

3 Empirical Strategy

I employ the Northstar case as a natural experiment within a difference-in-differences framework. In this section, I show the main regression specifications that I am estimating.

3.1 Facility-pollutant-level Regression Specifications

I define a treatment dummy *Ontario* that equals one for facilities that are located in Ontario and zero for facilities located in Quebec. Moreover, I define the indicator *Post* that equals one for years starting in 2014, the first full year following the Northstar settlement which took place on October 28, 2013. The main specification that I estimate is

$$\text{Log}(\text{Pollution}_{p,f,c,t}) = \beta \text{Post}_t \times \text{Ontario}_f + \alpha_f + \alpha_{I,t} + \alpha_{p,t} + \epsilon_{p,f,c,t} \quad (2)$$

where the pollutant p was released in year t by facility f which is owned by company c . α_f are facility fixed effects, $\alpha_{I,t}$ are industry-year fixed effects and $\alpha_{p,t}$ are pollutant-year fixed effects. Facility fixed effects control for time-invariant characteristics of facilities. Industry (facility NAICS 3-digit)-year fixed effects control for trends at the industry level. Pollutant-year fixed effects control for trends at the pollutant level and account for the fact that pollutants are not comparable in terms of unit (kgs or tons) and toxicity. A more stringent specification which controls for time-variant changes at the company level includes company-year fixed effects. This specification estimates the effects of Northstar on pollution for facilities located in Ontario relative to pollution for facilities located in Quebec and owned by the same corporation.¹⁸ It is relevant in this setting because enforcement of personal liability may have changed financials, liability insurance coverage and governance structure (Naaraayanan et al., 2021, Ivanova et al., 2022) which

¹⁸This accounts for about one third of the sample.

are changes at the company level. In some specifications, I include facility-pollutant fixed effects rather than facility fixed effects since the outcome variable is at the facility-pollutant level. In all specifications, I cluster standard errors at the province-industry (facility NAICS 3-digit) level and provide robustness tests where standard errors are clustered at the industry, company, facility and pollutant levels.

The main dependent variable is the natural logarithm (logarithm base e) of pollution in kgs or tons at the facility-pollutant-year level. For robustness, I also estimate the main specification where the dependent variable is the natural logarithm of one plus pollution in grams as the literature typically does (Akey et al., 2021, Bellon, 2021). Additionally, I estimate the main specification using a Poisson model rather than OLS as pollution data is skewed and concentrated in values that are null or close to zero (Cohn et al., 2022).

Using the same specification, I consider other outcome variables to study margins of response. I conduct the analysis for the ratio of pollution to the annual hours of operation and for a dummy that equals one if a pollutant is released by a facility in a given year. I also consider the natural logarithm of the annual hours of operation at the facility-year level (I exclude the year-pollutant fixed effects in this specification).

Moreover, I study the heterogeneity in responses following Northstar using the same specification and splitting the sample based on the company-level employment and Z-score (for public firms) in 2013, the year of the settlement. Finally, I conduct a triple-difference analysis using firms that are not financially constrained based on their employment and Z-score in 2013 as a benchmark group. I estimate the following specification

$$\begin{aligned} \text{Log(Pollution}_{p,f,c,t}) = & \beta_1 \text{Post}_t \times \text{Ontario}_f + \\ & \beta_2 \text{Post}_t \times \text{Ontario}_f \times \text{Distress 2013}_c + \alpha_f + \alpha_{I,t} + \alpha_{p,t} + \epsilon_{p,f,c,t} \end{aligned} \quad (3)$$

where the interaction terms of interest are written down. *Post* and *Ontario* are defined as above. *Distress 2013* is a dummy that equals one if the firm-level employment in 2013 is below the median and zero if it is above. Alternatively, it is a dummy that equals one if the Z-score (for public firms) in 2013 is below 1.81 and zero if the Z-score is above 2.99, as defined by Altman, 1968. The same fixed effects as previously mentioned are included

in the specification.

3.2 Company-level Regression Specifications

The empirical strategy that I use to study the effects of Northstar on company-level outcomes such as D&O liability insurance and board composition and size is similar as above but consider a slightly different treatment indicator. For insurance outcomes, I define a treatment dummy *Ontario* that equals one for corporations whose headquarters are located in Ontario and zero for corporations whose headquarters are in Quebec.¹⁹ For board outcomes, I define the treatment variable *Ontario* as a dummy that equals one if the company owns at least one facility in Ontario and zero otherwise.²⁰ I estimate the difference-in-differences specification

$$Y_{c,t} = \beta \text{Post}_t \times \text{Ontario}_c + \alpha_c + \alpha_t + \epsilon_{c,t} \quad (4)$$

where $Y_{c,t}$ is the outcome for company c in year t . α_c are company fixed effects, and α_t are year fixed effects. Some specifications include industry-year fixed effects.

To study the effects of Northstar on liability insurance, I consider various outcomes, $Y_{c,t}$, including the D&O liability insurance total coverage, the D&O liability insurance coverage per director, the D&O liability insurance total premium, the D&O liability insurance premium per director and the premium per unit of insurance coverage.

I conduct the same analysis considering the number of directors and the number of environmental expert directors on boards as outcome variables.

Finally, I study the effect of Northstar on market value for firms whose headquarters are located in Ontario. I estimate the following regression

$$\text{BHAR}[0,5]_c = \beta \mathbf{1}_{\text{Northstar}} \text{Industry}_c + \Gamma' \text{Controls}_c + \epsilon_c \quad (5)$$

¹⁹This will be improved in a future version of the paper as I am collecting more insurance data and will be able to provide more precise information about the location of these companies' facilities.

²⁰I obtain the location of companies' facilities by merging the BoardEx and the NPRI datasets by hand.

where the dependent variable is the Buy-and-Hold Abnormal Returns over five business days following the day of the Northstar settlement (October 28, 2014) for firm c . It is computed as follows

$$\text{BHAR}[0,5]_c = \prod_{k=0}^5 (1 + r_{c,k}) - \prod_{k=0}^5 (1 + r_{m,k}) \quad (6)$$

where $r_{c,t}$ is the return of firm c on day k and $r_{m,k}$ is the market return (TSX Composite index) on day k . The independent variable *Northstar Industry* is a dummy that equals one for firms that belong to the manufacturing industry (NAICS 33). Controls include past Buy-and-Hold Abnormal returns over the previous 10 business days and the previous 30 business days. Standard errors are robust.

4 Sample and Descriptive Statistics

4.1 Facility-Pollutant-Level Data

The pollution data is from the National Pollutant Release Inventory (NPRI), which reports pollution at the facility-pollutant level in Canada. The NPRI is legislated under the Canadian Environmental Protection Act (1999), and annual disclosure is mandatory for firms operating facilities in Canada. Facilities that employ at least 10 full-time employees, engage in certain activities, or manufacture, process, use, or release specific pollutants above a set threshold must disclose their pollution emissions, disposals, and transfers.²¹ Pollution is self-reported. Enforcement of disclosure is carried out through on-site inspections, audits, and penalties. Lack of coverage has been identified as a key issue with NPRI data until 2007, when reporting requirements were significantly adjusted. This analysis uses data from 2010 to 2017, a period during which reporting requirements remained relatively stable (Edwards et al., 2019).

The NPRI focuses on reporting pollutants based on weight in tons or kilograms and

²¹For example, activities such as exploration and drilling of oil and gas wells, small-scale production at non-open pit mines, and minor discharge of wastewater from wastewater collection systems do not require reporting. See the <https://publications.gc.ca/site/eng/9.506026/publication.html> for more details on reporting requirements.

does not consider toxicity. Pollutants are classified based on their reporting thresholds. Pollutants classified as “1A” by the NPRI must be reported if annual total releases by the facility exceed 10 tons or if their concentration in the release is 1% or more. Pollutants classified as “1B” by the NPRI have lower reporting thresholds, quantified in kilograms rather than tons (for example, mercury must be reported if yearly total releases exceed 5 kilograms). Facilities may also report Criteria Air Contaminants (CACs) which are carbon monoxide, nitrogen oxides, particulate matters, volatile organic compounds. I discard them from my analysis to focus on toxic pollutants (those that are classified “1A” or “1B”) as CACs are released as the result of combustion of fossil fuels and are not the main focus of the environmental regulator. Among toxic pollutants, I discard those whose reporting thresholds have changed during the period 2010-2017.

The NPRI provides information on pollution releases into the ground, water, or air. For each release category, facilities must detail whether pollution is released through stacks, landfill disposal, discharges into water streams, storage, tailing management, etc. I aggregate all categories at the facility-pollutant-year level and exclude pollution from tailing management, as these are mining wastes that can be sold by companies in which case negative quantities are reported. I consider all air, ground, and water pollution as environmental orders can be issued for any type of release. Additionally, since pollutants can migrate from the ground or water to the air, they may be reported in either category. For example, Northstar Aerospace has historically reported trichloroethylene (one of the pollutants involved in the orders) as air pollution although the environmental order involved contamination to water, ground and air.

For the period of interest in this study (2011-2016), 154 toxic pollutants were reported by 1,758 facilities (1,268 companies) across 47 NAICS 3-digit industries, located in either Ontario or Quebec. On average, companies in the sample have 2.78 facilities in Ontario and/or Quebec (the median is 1) and 4.6 facilities in any province across Canada (the median is 2). Chemical manufacturing, primary metal manufacturing, utilities and mining are the leading industries in both Ontario and Quebec. Beyond those, transportation equipment manufacturing is among the top sectors in Ontario, while

paper manufacturing is a key industry in Quebec. Table A2 in the Appendix presents the industries that report the most in Ontario and Quebec. Table A3 in the Appendix lists the pollutants that are the most reported in the sample.

Between 2011 and 2016, 1,239 facilities reported in Ontario while 519 reported in Quebec. Facilities in both provinces were about the same size in terms of number of employees and number of pollutants reported. On average, facilities in Ontario hired 232 employees (the median is 80) and reported on average 9.5 pollutants per year (the median is 6) per year. Facilities in Quebec hired 239 employees (the median is 80) and reported on average 8.8 pollutants per year (the median is 7).²²

4.1.1 Company-Level Data

Publicly listed companies in Canada are required by law to disclose about their Director and Officer liability insurance. The annual coverage, premium, and deductible are disclosed in management proxy circulars available on SEDAR.²³ Coverage refers to the total amount insurers may pay to companies to cover lawsuit-related expenses and applies to all directors and executives of the company. Premium is the total cost companies pay to insure their directors and executives. The deductible is the amount the company must contribute before the insurance coverage takes effect. For the period of interest (2011-2016), 98 companies reported their annual insurance coverage and premium (76 in 2013) which are part of 37 NAICS 3-digit industries. The industries that are the most represented are mining, real estate, finance, and manufacturing.²⁴

Information about board members is from BoardEx which covers both private and public firms. I merge BoardEx with the NPRI dataset which provides information about the location of facilities. The sample covers 117 firms. Among them, 54 companies

²²In the year of the settlement (2013), 962 facilities have reported in Ontario while 389 facilities have reported in Quebec. On average, facilities in Ontario hired 228.6 employees (the median is 78.5) and reported 9.3 pollutants (the median is 6) per year. Facilities in Quebec hired 240.4 employees (the median is 90) and reported 8.3 pollutants (the median is 7) per year.

²³This is the Canadian equivalent of EDGAR, an online database used by public companies in Canada to file mandatory documents with securities regulators.

²⁴A future version of the paper will incorporate a larger sample size and will consider only firms that I can merge with the NPRI dataset which provides information on the location of facilities. For now, the empirical strategy relies on considering headquarters in Ontario and Quebec for companies from all industries.

operate at least one facility in Ontario while 63 do not operate any facility in Ontario (any other province than Ontario is considered here).

Financial information and stock prices at the company level (for public firms) are from Compustat.

Table 1 describes the summary statistics for the main outcome variables. Panel A reports the summary statistics for the whole sample, while Panel B reports the summary statistics for the year of settlement (2013). Table A4 in the Appendix describes all outcome and independent variables used in the analysis.

[INSERT TABLE 1 HERE]

5 Results

5.1 Did Northstar Change Perceptions of Personal Liability Risk?

One expected effect of stronger enforcement of personal liability is that companies will purchase more D&O liability insurance for their directors and executives. To validate Northstar as a shift in the perception of personal liability risk by companies, I provide evidence that D&O liability insurance coverage increased following the announcement of the Northstar settlement.

I verify that there is no pre-trend in average coverage and premium between companies whose headquarters are in Ontario and those whose headquarters are in Quebec. Figure A2 plots the coefficients for the dynamic event study, using the year of the Northstar's directors and executives' settlement with the Ministry of Environment (2013) as the reference year. The OLS coefficients are estimated following the specification 4 but using a treatment variable for each year before and after the treatment year instead of a treatment variable that pools all years before and after the settlement. The coefficients account for the annual average difference in D&O liability insurance coverage between the control and treated groups relative to this difference in year 2013. They are around zero before

the year of the settlement and indicate that there is no significant difference in coverage between companies whose headquarters are in Ontario and those whose headquarters are in Quebec, controlling for time-invariant characteristics of companies (company fixed effects) and macroeconomic trends (year fixed effects). This is consistent with the parallel trend assumption to be verified which is necessary for the framework of difference-in-differences to be valid. Figure A2 also reports the dynamics for D&O liability insurance premium.

Table 2 shows the results following the estimation of the specification 4. The outcome variables are the total coverage (column (1)), the ratio of the total coverage to the number of directors (column (2)), the total premium (column (3)), the ratio of the total premium to the number of directors (column (4)), and the premium per unit of coverage (column (5)). I find that companies whose headquarters are in Ontario increased their D&O liability insurance coverage following the settlement of Northstar in 2013. The coefficients are significant at the 1% level (column (1)) and 5% (column (2)). They indicate that coverage within company increased by an average of 14.11 million Canadian dollars (column (1)) and 1.58 million Canadian dollars per director following Northstar (column (2)). The economic magnitude is substantial, as coverage within companies increased by an average of 16% relative to the mean, while coverage per director rose by 17%. Although I find that total premium increased on average by 60,000 Canadian dollars (column (3)) which accounts for a 13% increase relative to the mean, the estimates are not statistically significantly different from zero. Last, I do not find any effect in the premium-to-coverage ratio, suggesting that insurance companies did not perceive higher liability risk. This finding can be reconciled with the conclusions of Lu et al., 2024 who show that firms with better Corporate Social Responsibility (CSR) practices are more likely to purchase D&O liability insurance and have a lower premium-to-coverage ratio even when they operate in high-risk environments. Additionally, insurers did not suffer any loss in the Northstar case as the company had not purchased Side A insurance (which insures directly directors and executives when the company is not able to indemnify them), which could be another explanation of why insurers did not immediately

adjusted their perception of D&O liability risk following Northstar.

These findings suggest that companies perceived Northstar as a shift in the enforcement of personal liability. They support the use of the Northstar settlement as a positive shock to personal liability risk.

[INSERT TABLE 2 HERE]

5.2 Baseline Results

I now investigate the effects of Northstar on corporate pollution. A priori, it is unclear whether real outcomes are affected by increased personal liability risk if companies can fully insure their directors and executives.

I verify that there is no pre-trend in average pollution between facilities located in Ontario and facilities located in Quebec before the Northstar settlement. Figure 3 plots the coefficients for the dynamic event-study using the year of the Northstar settlement with the Ministry of Environment (2013) as the reference year. The OLS coefficients are estimated following the specification 2 but using a treatment variable for each year before and after the settlement, instead of a treatment variable that pools all years after the settlement. The coefficients account for the average difference in pollution between the control and treated group relative to the year of the settlement, 2013. They are around zero before the year of the settlement and indicate that there is no significant difference in average pollution between facilities located in Ontario and facilities located in Quebec, controlling for time-invariant facilities' characteristics (facility fixed effects), trends at the industry level (industry-year fixed effects) and at the pollutant level (pollutant-year fixed effects). This is consistent with the parallel trend assumption to be verified which is necessary for the framework of difference-in-differences to be valid. Figure A3 in the Appendix plots the dynamics for the specification that includes company-year fixed effects. Figure A4 in the Appendix plots the long-term dynamics.

[INSERT FIGURE 3 HERE]

Table 3 shows the results following the estimation of the specification (2). The de-

pendent variable is the natural logarithm of pollution at the facility-pollutant-year level. I find that facilities located in Ontario reduced pollution relative to facilities located in Quebec, following the Northstar settlement in 2013. Estimates indicate that pollution in Ontario decreased on average by 23% ($\exp(0.21)$) relative to pollution in Quebec following Northstar, within facility and controlling for trends at the industry (NAICS 3-digit) and pollutant level. It is statistically significant at the 1% level (column (3)). Moreover, I find that, among facilities that belong to the same firms, pollution in Ontario decreased on average by 33% ($\exp(0.29)$) relative to pollution in Quebec following Northstar, within facility and controlling for trends at the industry (NAICS 3-digit) and pollutant level. It is statistically significant at the 1% level (columns (7)).²⁵ Table 3 also reports the OLS coefficients estimated from including facility-pollutant fixed effects rather than facility fixed effects. The estimates are significant and indicate an average decrease of pollution in Ontario of 11% relative to pollution in Quebec following Northstar, within facility-pollutant and controlling for industry (NAICS 3-digit) and pollutant trends (column (4)). When conducting the analysis within firm, I find an average decrease of pollution in Ontario of 27% relative to pollution in Quebec following Northstar, within facility-pollutant and controlling for industry and pollutant trends (column (8)).

[INSERT TABLE 3 HERE]

I conduct several robustness checks that are presented in the Appendix. Table A5 shows the baseline results with different levels of clustering for standard errors (industry (NAICS 6-digit), company, facility, pollutant levels). Table A6 reports the baseline results for alternative time periods (2011-2015 in Panel A, 2011-2017 in Panel B). Table A7 reports results for releases of the 21 pollutants that are the most reported by facilities in Quebec and Ontario and listed in Table A3 in the Appendix. It shows that the baseline results hold when the analysis is restricted to the most reported pollutants, confirming that outlier pollutants are not driving the results. Table A8 reports the results when the dependent variable is one that is used in the literature, that is the logarithm of pollution in kilograms plus one (e.g., Akey et al., 2021, Bellon, 2021). It also shows the coefficients

²⁵The sample of facilities that belong to the same firms accounts for about a third of the total sample.

estimated using a Poisson model, which may be more appropriate for pollution data that is non-negative, skewed and concentrated near zero values (Cohn et al., 2022). In both cases, I find that the baseline results hold, but they do not when including year-company fixed effects.

5.3 How did Facilities Reduce Pollution?

In this section, I study how facilities reduced pollution. They have different methods for achieving this, including reducing pollution in the extensive margin by, for example, cutting production and replacing certain pollutants. They could also reduce pollution in the intensive margin by, for instance, investing in less polluting technologies and implementing better monitoring. I provide evidence that facilities have reduced pollution in the intensive margin.

Table (4) shows the effects of Northstar on the presence of pollutants reported by facilities (columns (1)-(3)), the hours facilities operate for (columns (4)-(6)) and the ratio of pollution to the hours of operation (columns (7)-(9)). I find that facilities did not change the composition of pollutants they used. The outcome variable in this test is a dummy that equals one when a pollutant was reported by a facility in a given year (columns (1)-(3)). Second, I find that facilities decreased their annual hours of operation by 1% to 2% but the estimates are not statistically significantly different from zero (columns (4)-(5)).²⁶ Third, I find that facilities in Ontario reduced scaled pollution on average by 19% ($\exp(0.18)$) relative to facilities in Quebec following Northstar, within facility and controlling for trends at the industry (NAICS 3-digit) and pollutant level. This estimate is statistically significant at the 1% level (column (7)) and ranges from 12% to 16% when considering within-firm specifications (column (8)-(9)). This table suggests that facilities decreased pollution intensity following Northstar which may be the result of more investment in cleaner production technologies.

[INSERT TABLE 4 HERE]

²⁶One interpretation is that facilities shut down for maintenance following Northstar as anecdotal evidence suggests.

5.4 Heterogeneity

In this section, I explore heterogeneity in the baseline results. In particular, I study the role of company financial resources.²⁷ A priori, it is unclear how firms' financial resources will affect facilities' reduction in pollution. On the one hand, they have fewer financial resources and may be at greater risk of financial distress if they receive a remediation order. Therefore, directors and executives are more likely to face personal liability when their firms are financially constrained. On the other hand, reducing pollution is costly and financially constrained firms may not be able to afford it.

Table 5 presents the results. First, I use company-level employment data from the NPRI database as a proxy for the company's financial constraints (Panel A). I define a dummy variable that equals one if the company's number of employee count in 2013 exceeded the median company-level employee count in the sample for that year. Using a triple-difference analysis where small companies are the benchmark group, I do not find a significant difference between small and large firms, showing that the baseline results are not concentrated in either type of firms. When considering split samples, I find that facilities in Ontario reduced pollution relative to facilities in Quebec following Northstar when facilities were owned by large companies. Exploring this result further, I show in Table A9 in the Appendix that the baseline results are driven by private firms rather than public firms.

Second, I compute Altman Z-scores for companies that are public. Consistently with the company employment heterogeneity results, I find that facilities whose firms have a high Z-score ($Z\text{-score} > 2.99$), that are firms that are far from financial distress, react the most to Northstar and reduce pollution relative to their peers in Quebec. I do not find any effect significantly different from zero for financially distressed companies.

[INSERT TABLE 5 HERE]

²⁷A future version of the paper will include data on the financial constraints of facilities.

5.5 Effects of Northstar on Board Size and Composition

In this section, I study the effects of Northstar on corporate boards. A priori, it is unclear whether stricter enforcement of personal liability for directors and executives will cause boards to expand or shrink and alter their composition. On the one hand, directors and executives may fear personal liability and leave boards. On the other hand, firms may try to retain them by mitigating the higher personal liability risk (e.g., by increasing insurance coverage). Moreover, firms may seek to hire directors with experience in pollution reduction, although these directors may also be the ones most at risk of personal liability in the event of a remediation order.

To provide insight into these questions, I merge the NPRI and BoardEx datasets and perform the same type of difference-in-differences analysis as previously conducted. I verify that there is no pre-trend in the average number of environmental expert directors between companies that own facilities in Ontario and facilities that do not. Figure 4 plots the coefficients for the dynamic event-study using the year of the Northstar settlement with the Ministry of Environment (2013) as the reference year. The OLS coefficients are estimated following the specification 4 but using a treatment variable for each year before and after the settlement, instead of a treatment variable that pools all years after the settlement. The coefficients account for the average difference in the number of environmental expert directors between the control and treated group relative to the year of the settlement, 2013. They are around zero before the year of the settlement and indicate that there is no significant difference between firms that own facilities in Ontario and firms that do not, controlling for time-invariant companies' characteristics (company fixed effects), and macroeconomic trends (year fixed effects). This is consistent with the parallel trend assumption to be verified which is necessary for the framework of difference-in-differences to be valid.

[INSERT FIGURE 4 HERE]

Table 6 presents the results from estimating Equation (4) for the total number of directors (columns (1)-(2)), the number of environmental expert directors (columns (3)-(4))

and the ratio of environmental expert directors to the total number of directors (columns (5)-(6)). Environmental expertise is measured by whether directors were part of a corporate committee addressing environmental sustainability at any point in their career prior to 2013. While I find that the board size decreases by an average of 8%, the estimates are not statistically significantly different from zero (columns (1)-(2)). I find that companies that own at least one facility in Ontario experienced a significant reduction in the number of environmental expert directors within their boards relative to companies who do not own any facility in Ontario following Northstar. The magnitude of the effect ranges from 19% (0.23/1.19) to 32% (0.39/1.19) and is significant at the 1% level when including year-industry fixed effects. Moreover, combining those two effects, I find that the representation of environmental expert directors on boards decreases by an average of 13% to 26% following Northstar. Because the dependent variables are counts of directors and non-negative integers, I also estimate the specifications with a Poisson model. I show the results in Table A10 in the Appendix and find the same effects and the same economic magnitudes. Overall, these results suggest that environmental expert directors who are in charge of disclosing corporate environmental risk and managing the company's environmental policy fear greater personal liability risk following environmental misconduct and are not retained by corporations.

[INSERT TABLE 6 HERE]

6 Effects of Northstar on Firm Performance

I now investigate the effects of Northstar on firm value. Personal liability is a cost that is directly applied to individuals within the corporation which may suggest that firm performance is not affected. However, as shown in the earlier sections, firms may react by purchasing more liability insurance, investing into cleaner production processes and they may lose key directors, which are costs to the company.

To provide insight into the costs to shareholders and impact on welfare, I compute the buy-and-hold abnormal returns (BHARs) following the Northstar which occurred on

October 28, 2013. The Ontario Land Tribunal approved the settlement at a hearing on the same date. This was reported by national newspapers on the same day (McFarland, 2013). Figure 5 plots the average BHARs for companies whose headquarters are in Ontario and operate within the manufacturing industry (NAICS-33) which is the industry Northstar Aerospace Inc operated in. It shows a sharp decline in average BHARs following the announcement of the settlement on October 28, 2013 and average BHARs remain lower than zero in the days following the settlement. This means that companies whose headquarters are in Ontario and operate in the manufacturing industry underperformed the market (based on the Toronto Composite Index) following Northstar. Figure A5 in the Appendix shows that the decline in average BHARs was experienced by all firms belonging to polluting industries (manufacturing, mining, utilities, waste management) and whose headquarters are in Ontario (Panel A) while firms whose headquarters are in Quebec do not exhibit the same market reaction (Panel B).

[INSERT FIGURE 5 HERE]

Table 7 reports the OLS regression coefficients from estimating the specification 5. It shows that, among firms whose headquarters are in Ontario, firms that belong to the manufacturing industry (NAICS-33) experienced larger declines in returns relative to firms in other industries, controlling for past returns (column (2)). The average effect is 3% over five business days and significant at the 5% level. Additionally, I find that smaller firms in terms of market capitalization underperformed the market by 5% over five business days. Larger firms in terms of market capitalization underperformed the market by 2% although the estimate is not statistically different from zero. These results suggest that the market views the enforcement of personal liability as a cost that may hinder optimal business growth.

[INSERT TABLE 7 HERE]

7 Discussion

Is Northstar an off-equilibrium shock to personal liability risk? Yes, it is likely that perceptions of high personal liability risk do not persist after such shocks, as legislation, insurance contracts, and the compensation and agreements offered by firms to their directors and executives may adjust to hedge against the new liability risk. For instance, following a large increase in lawsuits filed against directors in the 1980s in the U.S., D&O liability insurance became unaffordable, and states enacted legislation to limit the liability of directors (Coffee, 1987, Romano, 1989).²⁸ It is precisely because the situation is off-equilibrium and represents a credible change in the expected personal liability risk that we can learn about the effects of enforcing personal liability.

That said, the external validity of this analysis is not limited by this. Some environmental legislation in other jurisdictions includes personal liability provisions, such as the U.S. federal CERCLA legislation and environmental laws in other Canadian provinces. Hence, this research provides evidence of the effects we can expect if regulators choose to implement this provision and courts enforce it, or if shareholders view corporate environmental strategies as part of directors' and executives' fiduciary duties.

This research provides insights for policymakers who may wish to enforce personal liability (which is sometimes already enacted in legislation) when standard mechanisms may be ineffective (e.g., corporations may file for bankruptcy strategically to avoid liability following misconduct (Resnick, 1999, Gupta et al., 2019)) or to address irreversible issues such as environmental degradation. However, this research is purely positive rather than normative. While the Northstar case provides a setting in which we can quantify the real effects and learn about some of the benefits and costs of enforcing of personal liability, there may be other welfare effects that I do not observe and take into account. For example, directors and executives might avoid taking beneficial business risks or delay filing for bankruptcy.

²⁸Smith v. Van Gorkom (1985) is one of the major cases of that period and remains landmark in the U.S. Directors of Trans Union were sued by shareholders following the sale of the company. The Delaware Supreme Court held that the directors breached their duty of care by failing to adequately inform themselves about the transaction and thus were personally liable.

What are the implications of stricter enforcement of personal liability for corporate governance? Here, we need to distinguish between derivative lawsuits (where directors and executives are sued by shareholders, as in the case against Shell’s directors) and third-party lawsuits (where directors and executives are sued by employees, customers, or governmental agencies, as in the Northstar case).²⁹ In the former case, directors and executives are defendants in lawsuits brought by shareholders, and personal liability strengthens shareholders’ influence on corporate policies. In the latter case, both the corporation (i.e., shareholders) and the directors/executives may be defendants in a lawsuit brought by a third party. Hence, the implications for corporate governance are less clear. Shareholders may already understand corporate environmental issues and may push firms to adopt environmental policies (Hart et al., 2022), in which case interests are already aligned between agents and principals and personal liability may not have a great impact on governance structures. On the other hand, shareholders may not be in favor of adopting environmental policies or may not have the ability to influence decision-making (Bauer et al., 2021, Hart et al., 2024), in which case personal liability may amplify conflicts of interest between corporate agents and principals.

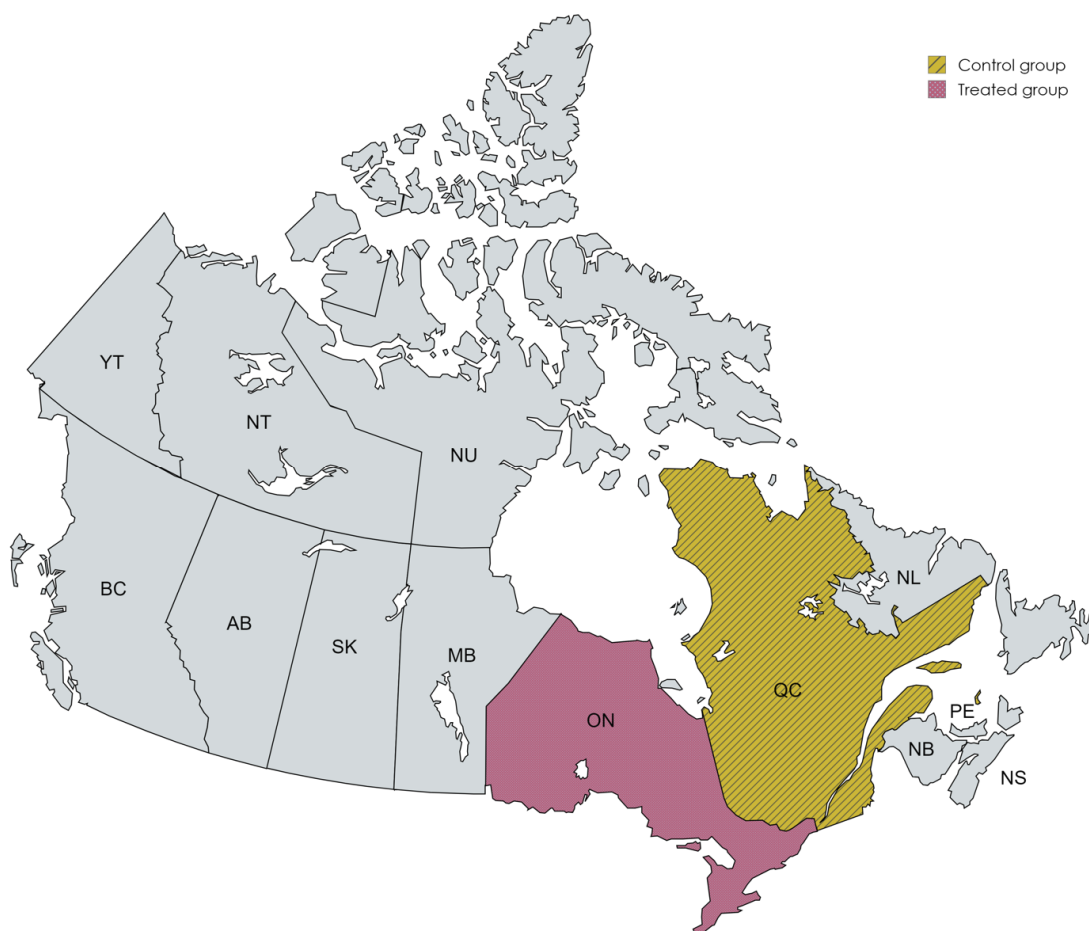
8 Conclusion

Executives and directors are increasingly at risk of personal liability for corporate environmental misconduct. However, the literature so far has provided limited evidence on the impacts of enforcing personal liability on real outcomes and its associated costs. This paper addresses this gap by using a court case where out-of-pocket personal liability was enforced for environmental violations as a quasi-natural experiment. I find that personal liability leads to an economically meaningful reduction in corporate pollution. Firms reduce pollution in the intensive margin and may increase liability insurance as well. I show that firm value declines, highlighting a trade-off between the social benefits of personal liability and its costs to shareholders. These results, combined with the urgency of cli-

²⁹The Shell case is documented in <https://www.theguardian.com/environment/2023/feb/09/shell-directors-personally-sued-over-flawed-climate-strategy>

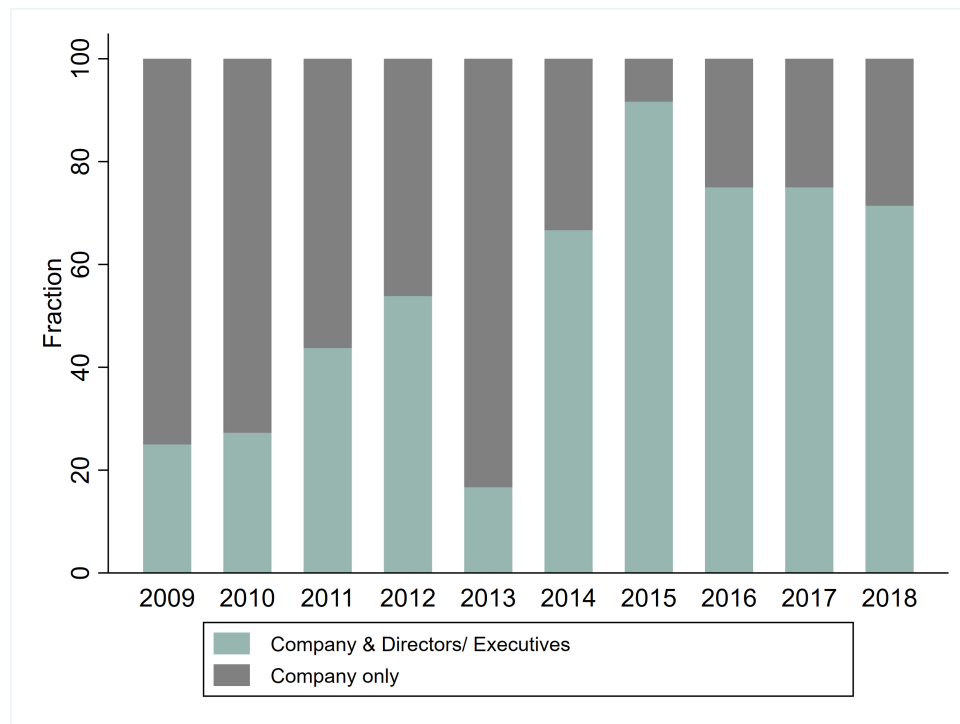
mate change, suggest that the decision to fully shield corporate directors and executives from liability for corporate externalities may need to be reconsidered by policymakers, courts, and society at large.

Figure 1: Canadian Provinces as Treated and Control Groups



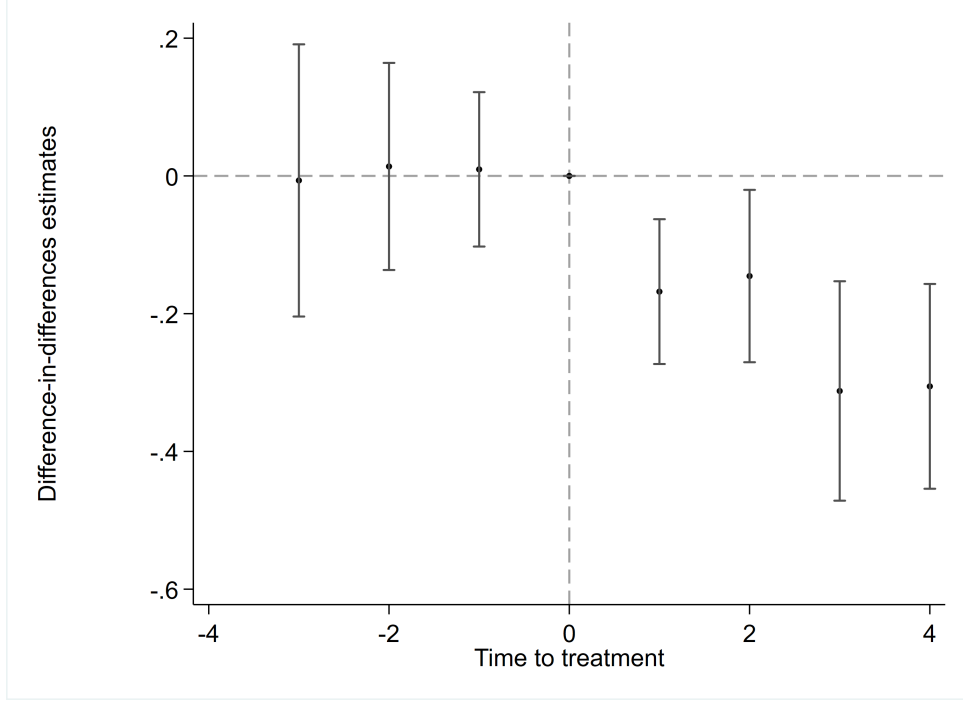
This map shows the two Canadian provinces used in the analysis as the treated (Ontario, ON) and control (Quebec, QC) groups.

Figure 2: Ratio of Directors and/or Executives Named in Environmental Orders in Ontario



This figure shows the ratio of corporate directors and executives included in environmental orders to the total number of orders issued by the Ministry of the Environment of Ontario and publicly available. The data was manually collected from the Environmental Registry of Ontario website.

Figure 3: Dynamics Treatment Effects on Facility-Pollutant-level Pollution

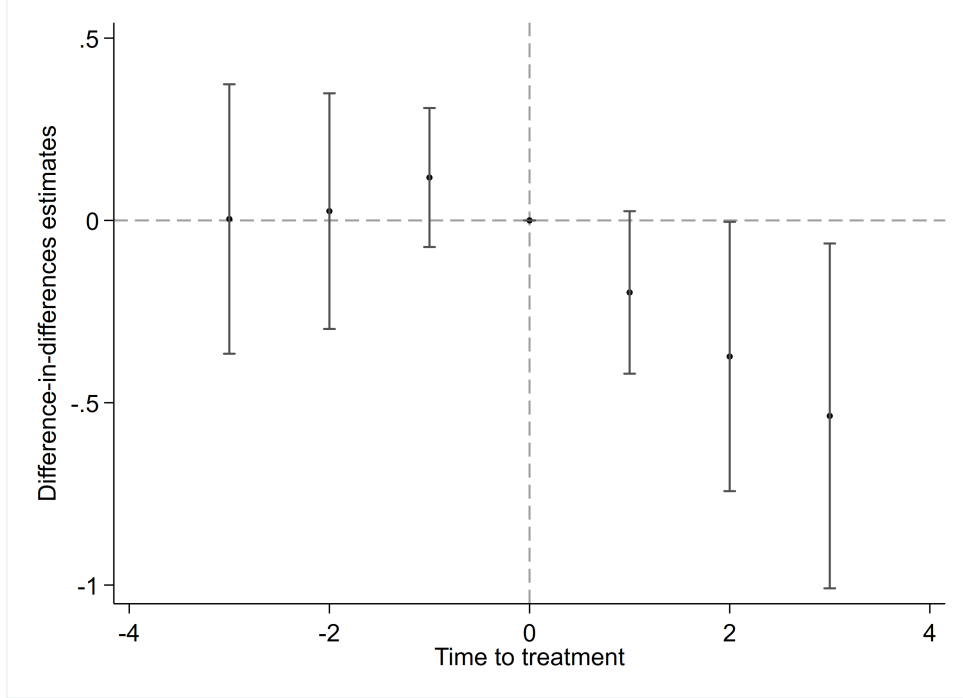


This figure reports the coefficients and confidence intervals at the 10% level of a dynamic event-study around the year of the Northstar settlement. The data is at the facility-pollutant-year level between 2010 and 2017 (included) and the reference year where $t=0$ corresponds to 2013, the year of the settlement. The treated group is the set of facilities that are located in Ontario while the control group is the set of facilities that are located in Quebec. Reported coefficients, β_k , are estimated testing the specification

$$\text{Log}(\text{Pollution}_{f,p,t}) = \sum_{k=2010, k \neq 2013}^{2017} \beta_k \text{Year}_{k,t} \times \text{Ontario}_f + \alpha_f + \alpha_{p,t} + \alpha_{I,t} + \epsilon_{f,p,t}$$

where α_f are facility fixed effects, $\alpha_{p,t}$ are pollutant-year fixed effects, $\alpha_{I,t}$ are industry-year (3-digit NAICS). Standard errors are clustered at the province-industry (3-digit NAICS) level.

Figure 4: Dynamics Treatment Effects on the Company-level Number of Environmental Expert Directors

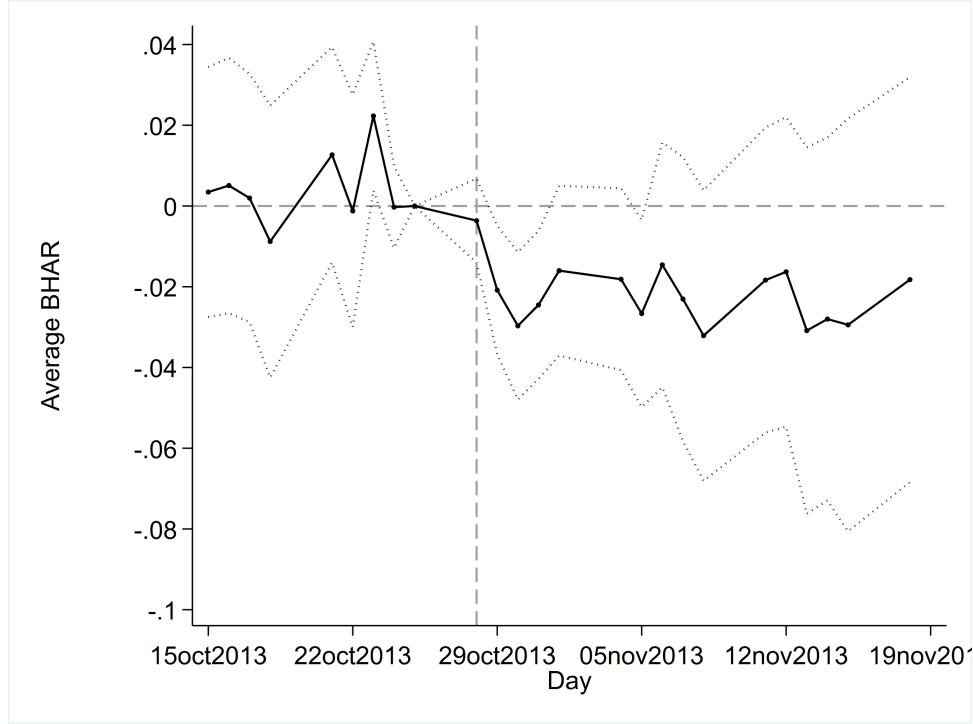


This figure reports the coefficients and confidence intervals at the 10% level of a dynamic event-study around the year of the Northstar settlement. The data is at the company-year level between 2010 and 2016 (included) and the reference year where $t=0$ corresponds to 2013, the year of the settlement. The dataset includes firms that are both in the BoardEx and the NPRI datasets. The treated group is the set of companies that own facilities that are located in Ontario while the control group is the set of companies that own facilities that are located in Quebec. Reported coefficients, β_k , are estimated testing the specification

$$\# \text{ Experts}_{c,t} = \sum_{k=2010, k \neq 2013}^{2016} \beta_k \text{Year}_{k,t} \times \text{Ontario}_f + \alpha_c + \alpha_t + \epsilon_{c,t}$$

where α_c are company fixed effects, α_t are year fixed-effects. Standard errors are clustered at the province-industry (3-digit NAICS) level.

Figure 5: Average Buy-and-Hold Abnormal Returns around Northstar in Ontario



This figure reports the daily average buy-and-hold abnormal returns (BHAR) for companies that are listed on the Toronto Stock Exchange or the Toronto Stock Exchange Venture. Firms that are considered here have their headquarters in Ontario and belong to the same manufacturing sector as Northstar Aerospace did (NAICS 33). BHAR at time k for company i is calculated as follows

$$\text{BHAR}_{i,[-10,k]} = \prod_{t=-10}^k (1 + r_{i,t}) - \prod_{t=-10}^k (1 + r_{m,t})$$

where $r_{i,t}$ is the return of firm i on day t , $r_{m,t}$ is the market return (TSX Composite index) on day t . Confidence intervals are computed at the 10% level. The red vertical line is the day of the Northstar settlement (October 28, 2013).

Table 1: Summary Statistics

Panel A: Years 2011-2016

	Observations	Mean	Median	SD
Facility-pollutant-year Panel				
Pollution (kgs)	31,817	33,265	84	686,609
Log(Pollution (kgs))	29,823	4.74	4.79	4.06
Facility-year Panel				
Hours of Operation	5,053	6,406	7,462	2,599
Log(Hours of Operation)	4,969	8.68	8.92	0.51
Number of Employees	8,241	234	80	630
Log(Number of Employees)	8,222	4.34	4.38	1.50
Company-year Panel				
Number of Employees	2,870	452	105	2,534
D&O Insurance Coverage (million)	454	90	55	91
D&O Insurance Premium (million)	453	0.47	0.19	0.62
# Directors (Insurance Data)	454	9.55	9	2.80
# Directors (BoardEx)	561	4.80	4	3.77
# Experts (BoardEx)	561	1.16	0	1.95

Panel B: Year of Settlement (2013)

	Observations	Mean	Median	SD
Facility-pollutant-year Panel				
Pollution (kgs)	5,208	37,963	83	861,591
Log(Pollution (kgs))	4,885	4.76	4.80	4.07
Facility-year Panel				
Hours of Operation	1,009	6,409	7,282	2,558
Log(Hours of Operation)	994	8.68	8.92	0.50
Number of Employees	1,351	232	80	590
Log(Number of Employees)	1,350	4.35	4.38	1.50
Company-year Panel				
Number of Employees	924	475	110	2,595
D&O Insurance Coverage (million)	77	83	50	84
D&O Insurance Premium (million)	76	0.45	0.20	0.57
# Directors (Insurance Data)	77	9.49	9	2.82
# Directors (BoardEx)	97	4.68	4	3.76
# Experts (BoardEx)	97	1.14	0	1.99

These tables present the summary statistics for the pollution data from NPRI, D&O liability insurance data from SEDAR, the board data from BoardEX (merged with NPRI) for years 2011-2016 (Panel A) and the year of settlement, 2013 (Panel B).

Table 2: Effects of Northstar on D&O Liability Insurance

	Total Coverage	Coverage/Director	Total Premium	Premium/Director	Premium/Coverage
	(1)	(2)	(3)	(4)	(5)
Post x Ontario	14.11*** (5.10)	1.58** (0.67)	0.06 (0.04)	0.00 (0.00)	-0.00 (0.00)
Fixed Effects					
Year	Yes	Yes	Yes	Yes	Yes
Company	Yes	Yes	Yes	Yes	Yes
Observations	442	442	442	442	442
R-squared	0.96	0.90	0.93	0.90	0.86
Sample Mean	88.819	8.916	0.463	0.046	.005
Unit: million of dollars					

This table reports the effects of Northstar on the total company-level D&O liability coverage (column (1)), the ratio of the company-level coverage to the number of directors (column (2)), the total company-level premium (column (3)), the ratio of the company-level premium to the number of directors (column (4)), and the ratio of the company-level premium to the company-level coverage (column (5)). It reports the OLS coefficients estimated following the specification 4. All industries in the insurance sample are considered. All variables are in million of dollars and winsorized at the 97.5% level. *Post* is a dummy that equals one for years following the Northstar settlement (2014 - 2016) and zero for years before (2011 - 2013). *Ontario* is a dummy that equals one for companies whose headquarters are in Ontario and zero for companies whose headquarters are in Quebec. Standard errors are clustered at the industry (NAICS 6-digit)-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table 3: Baseline Results: Effects of Northstar on Facility-Pollutant-level Pollution

	Log(Pollution)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post x Ontario	-0.18** (0.08)	-0.21*** (0.07)	-0.21*** (0.07)	-0.11* (0.06)	-0.29** (0.11)	-0.25** (0.10)	-0.29*** (0.10)	-0.24** (0.09)
Fixed Effects								
Facility	Yes	Yes	Yes	-	Yes	-	Yes	-
Year	Yes	-	-	-	-	-	-	-
Facility-Pollutant	-	-	-	Yes	-	Yes	-	Yes
Year-Pollutant	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	-	-	Yes	Yes	-	-	Yes	Yes
Year-Company	-	-	-	-	Yes	Yes	Yes	Yes
Observations	29,904	29,904	29,904	28,854	28,366	27,237	28,366	27,237
R-squared	0.61	0.74	0.74	0.95	0.76	0.96	0.76	0.96

This table reports the effects of Northstar on pollution releases. It reports the OLS coefficients estimated following the specification 2. The dependent variable is the natural logarithm of pollution at the facility-pollutant-year level. *Post* is a dummy that equals one for years after the Northstar settlement (2014-2016) and zero for years before (2011-2013). *Ontario* is a dummy that equals one for facilities located in Ontario and zero for facilities located in Quebec. Standard errors are clustered at the industry (NAICS 3-digit)-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table 4: Margins of Response following Northstar

Panel Level	1(Pollution)			Log(Hours)			Log(Pollution/Hours)		
	Facility-Pollutant-Year			Facility-Year			Facility-Pollutant-Year		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post x Ontario	-0.00 (0.00)	0.01 (0.01)	0.01 (0.01)	-0.02 (0.01)	-0.01 (0.01)	-0.01 (0.02)	-0.18*** (0.05)	-0.15** (0.07)	-0.12* (0.07)
Fixed Effects									
Facility	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	-	-	-	Yes	-	-	-	-	-
Year-Pollutant	Yes	Yes	Yes	-	-	-	Yes	Yes	Yes
Year-Industry	Yes	-	Yes	-	Yes	-	Yes	-	Yes
Year-Company	-	Yes	Yes	-	-	Yes	-	Yes	Yes
Observations	31,493	29,894	29,894	4,778	4,740	2,033	20,619	19,782	19,782
R-squared	0.48	0.53	0.53	0.93	0.93	0.93	0.73	0.74	0.74

This table reports the facilities' response of Northstar in the composition of pollutants reported (columns (1)-(3)), the extensive margin (columns (4)-(6)) and the intensive margin (columns (7)-(9)). The dependent variable in columns (1)-(3) is a dummy that equals one if the facility releases a given pollutant in a given year and is at the facility-pollutant-year level. The dependent variable in columns (4)-(6) is the natural logarithm of hours of operation at the facility-year level. The dependent variable in columns (7)-(9) is the natural logarithm of the ratio of pollution to the annual hours of operation at the facility-pollutant-year level. It reports the OLS coefficients estimated following the specification 2. *Post* is a dummy that equals one for years after the settlement of Northstar took place (2014-2016) and zero for the years before (2011-2013). *Ontario* is a dummy that equals one for facilities located in Ontario and zero for facilities located in Quebec. Standard errors are clustered at the industry (3-digit NAICS)-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table 5: Effects of Northstar on Facility-Pollutant-level Pollution by Company-level Financial Constraints

Panel A: Employment (All Firms)					
Sample	All Firms	Log(Pollution)			
		Small		Large	
	(1)	(2)	(3)	(4)	(5)
Post x Ontario	0.16 (0.24)	-0.05 (0.10)	0.14 (0.09)	-0.24*** (0.08)	-0.31*** (0.11)
Post x Ontario x Employment 2013	-0.20 (0.14)				
Fixed Effects					
Facility	Yes	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes
Year-Industry	Yes	Yes	Yes	Yes	Yes
Year-Company	-	-	Yes	-	Yes
Observations	27,887	8,272	7,549	19,426	18,833
R-squared	0.74	0.79	0.81	0.74	0.75

Panel B: Altman Z-Score (Public Firms)					
Sample	All Firms	Log(Pollution)			
		Distressed		Healthy	
	(1)	(2)	(3)	(4)	(5)
Post x Ontario	-0.39* (0.20)	0.24 (0.17)	-0.09 (0.17)	-0.74** (0.29)	-1.55 (0.97)
Post x Ontario x Distress 2013	0.59** (0.24)				
Fixed Effects					
Facility	Yes	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes
Year-Industry	Yes	Yes	Yes	Yes	Yes
Year-Company	-	-	Yes	-	Yes
Observations	7,408	5,581	5,526	1,692	1,652
R-squared	0.72	0.71	0.72	0.80	0.80

This table reports the effects of Northstar on pollution releases by company size measured by the number of employees (Panel A) and by Altman Z-score (Panel B). It reports the OLS coefficients estimated following the specification 3 in column (1) where only the interactions of interest are reported. It reports the OLS coefficients estimated following the specification 2 for small (financially distressed in Panel B) firms (columns (2)-(3)) and large (financially healthy in Panel B) firms (columns (4)-(5)). The dependent variable is the natural logarithm of pollution at the facility-pollutant-year level. *Post* is a dummy that equals one for years after the Northstar settlement (2014-2016) and zero for years before (2011-2013). *Ontario* is a dummy that equals one for facilities located in Ontario. *Employment 2013* is a dummy that equals one if the company's number of employees in 2013 exceeded the median company-level employee count in the sample. *Distress 2013* is a dummy that equals one if the Altman Z-score is strictly smaller than 1.81 and one if the Altman Z-score is strictly larger than 2.99. Standard errors are clustered at the industry (4-digit NAICS)-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table 6: Effects of Northstar on Company-level Board Size and Composition

	#Directors		#Experts		#Experts/#Directors	
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Ontario	-0.40 (0.26)	-0.48 (0.30)	-0.23* (0.14)	-0.39*** (0.13)	-0.02** (0.01)	-0.04*** (0.01)
Fixed Effects						
Company	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	-	Yes	-	Yes	-
Year-Industry	-	Yes	-	Yes	-	Yes
Observations	534	534	534	534	510	510
R-squared	0.95	0.95	0.95	0.96	0.98	0.98
Mean Sample	4.89	4.89	1.19	1.19	0.15	0.15

This table reports the effects of Northstar on the number of directors (columns (1)-(2)), the number of expert directors who were part of an environmental committee before the year of settlement (columns (3)-(4)) and the ratio of expert directors to the total number of directors (columns (5)-(6)). It reports the OLS coefficients estimated following the specification 4 for companies that are both in the BoardEx and in the NPRI datasets. The panel is at the company-year level. *Post* is a dummy that equals one for years following the Northstar settlement (2014-2016) and zero for years before (2011-2013). *Ontario* is a dummy that equals one for companies that operate at least one facility in Ontario and zero for companies that do not operate any facility in Ontario. Standard errors are clustered at the industry-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table 7: Effects of Northstar on Abnormal Returns in Ontario

Sample	BHAR[0,5]			
	All Firms		Small	Large
	(1)	(2)	(3)	(4)
Northstar Industry	-0.02*	-0.03**	-0.05*	-0.02
	(0.01)	(0.02)	(0.03)	(0.01)
Constant	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Controls				
BHAR[-10,-1]	-	Yes	Yes	Yes
BHAR[-30,-11]	-	Yes	Yes	Yes
Observations	821	821	426	391
R-squared	0.00	0.03	0.04	0.01

This table reports the effect of Northstar on Buy-and-Hold Abnormal Returns (BHARs) for companies that are listed on the Toronto Stock Exchange or the Toronto Stock Exchange Venture and whose headquarters are in Ontario. BHARs are calculated for the 5 days that follow the Northstar settlement (October 28th, 2013) as

$$\text{BHAR}[0,5]_i = \prod_{t=0}^5 (1 + r_{i,t}) - \prod_{t=0}^5 (1 + r_{m,t})$$

Northstar Industry is a dummy that equals one if the company belongs to the industry the Northstar Aerospace Company belongs to (NAICS 33). Reported coefficients, β , are estimated testing the specification

$$\text{BHAR}[0,5]_i = \beta \mathbf{1}_{\text{Northstar Industry}}_i + \Gamma' \text{Controls}_i + \epsilon_i$$

where Controls are past BHAR at horizon [-10,-1] and [-30,-11]. Robust standard errors are reported in parentheses. Columns (3)-(5) report OLS estimates for companies as a function of their market capitalization. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

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A Appendix

Figure A1: Examples of Corporate Disclosure of D&O Liability Insurance

(a) Agrium Inc (2012)

DIRECTORS' AND OFFICERS' INSURANCE

We carry directors' and officers' liability insurance covering acts and omissions of our directors and officers and those of our subsidiaries. The policy has a covering limit of U.S. \$125,000,000 in each policy year. The total premiums paid by the Corporation in 2012 were U.S. \$896,775. The corporate policy provides for the Corporation to absorb a deductible amount of up to U.S. \$2,000,000 on securities claims, U.S. \$1,000,000 on Oppressive Conduct, U.S. \$1,000,000 on Canadian Pollution Claims and U.S. \$500,000 on all other claims.

Our by-laws provide for the indemnification of each director and officer against all costs, charges and expenses reasonably incurred by the director in respect of any action or proceeding to which the director is made a party by reason of being a director or officer of the Corporation, subject to limitations contained in our by-laws or the *Canada Business Corporations Act*. We also have agreements with each director and officer to provide indemnification to the extent permitted under the *Canada Business Corporations Act*.

(b) Wesdome Gold Mines

Directors' and Officers' Liability Insurance

As at the date of this Circular, the Company has in force a Directors' and Officers' Liability Insurance policy in the amount of \$20,000,000 for the benefit of the Company and its directors and officers. The amount of the premium paid by the Company for the policy now in effect was \$51,800. No portion of this premium was paid by the directors and officers of the Company. The policy provides for a deductible of \$50,000 for any loss in connection with claims against a director or officer relating to violations of Canadian securities laws, a deductible of \$50,000 for any loss in connection with claims resulting from wrongful employment practices, a deductible of \$50,000 for any loss in connection with Canadian pollution claims and a deductible of \$50,000 for other claims against directors and officers of the Company.

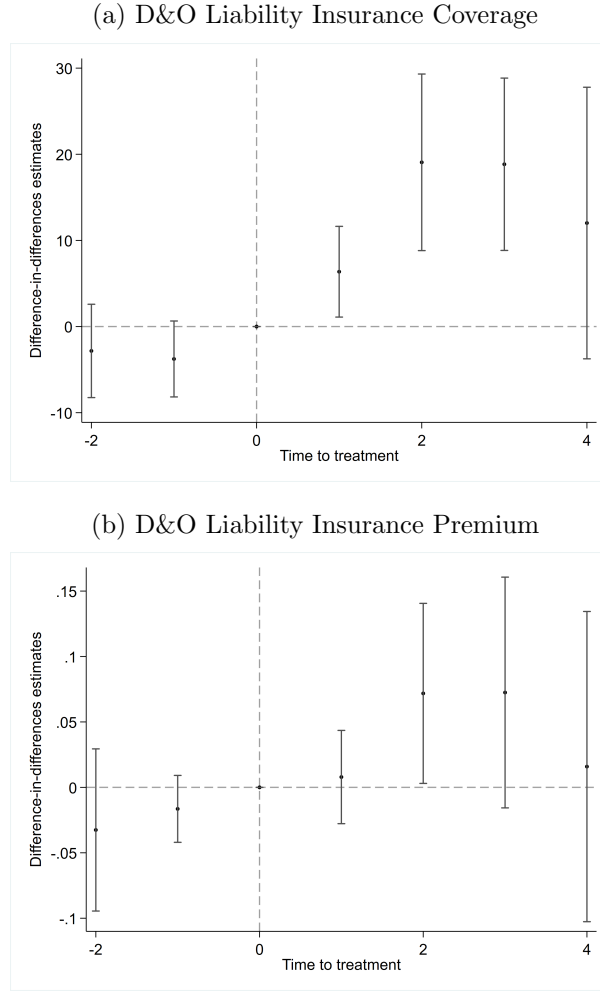
(c) Magna International (2013)

DIRECTORS' AND OFFICERS' INSURANCE

Effective September 1, 2013, Magna renewed its directors' and officers' liability insurance for a one-year renewal period. This insurance provides, among other coverages, coverage of up to \$270 million (in the aggregate for all claims made during the policy year) for officers and directors of Magna and its subsidiaries, subject to a self-insured retention of \$5 million for securities claims and \$1 million for all other claims. This policy does not provide coverage for losses arising from the intentional breach of fiduciary responsibilities under statutory or common law or from violations of or the enforcement of pollutant laws and regulations. The aggregate premium payable in respect of the policy year September 1, 2013 to September 1, 2014 for the directors' and officers' liability portion of this insurance policy was approximately \$2.0 million.

These are examples of D&O liability insurance disclosures made by the companies Agrium Inc, Wesdome Gold Mines, and Magna International. They come from the Management Information Circular forms reported by those companies on the Canadian system for electronic disclosure of securities regulatory filings (SEDAR).

Figure A2: Dynamics Treatment Effects on D&O Liability Insurance

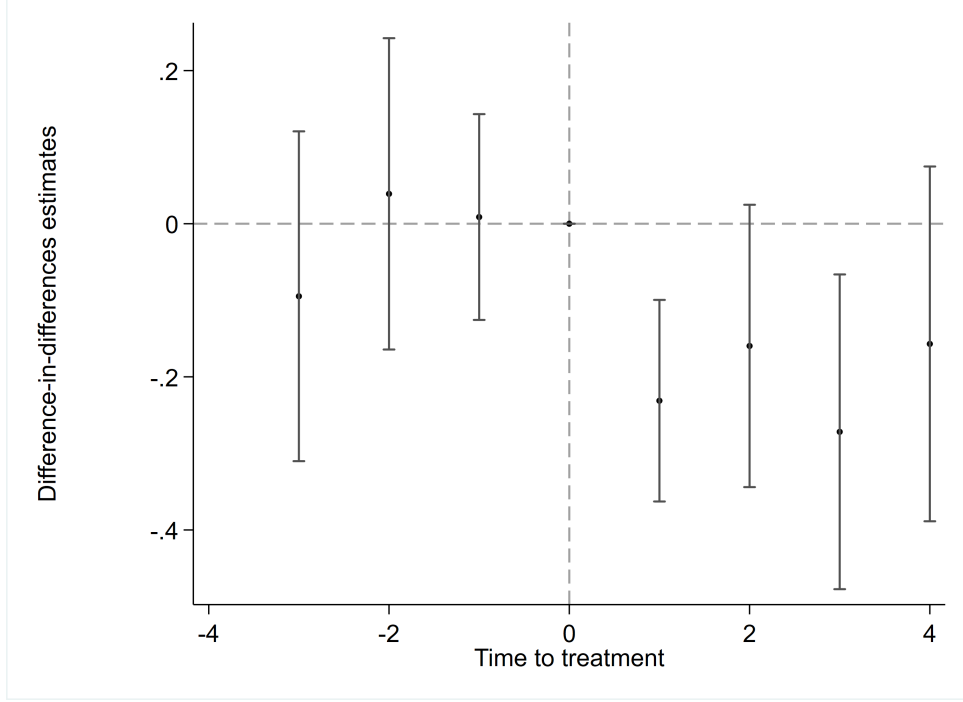


These figures show the dynamic DID effects estimated from

$$Y_{c,t} = \sum_{k=2011, k \neq 2013}^{2017} \beta_k \text{Year}_{k,t} \times \text{Ontario}_c + \alpha_c + \alpha_t + \epsilon_{c,t}$$

where $Y_{c,t}$ is the total insurance coverage (Figure (a)) and the total insurance premium (Figure (b)) at the company level, α_c are company fixed effects and α_t are year fixed effects. Standard errors are clustered at the industry (6-digit NAICS)-province level. The figures report confidence intervals at the 10% level. $t = 0$ corresponds to the year of the Northstar settlement, 2013. Dependent variables are winsorized at the 97.5% level. The treated group is the set of companies whose headquarters are located in Ontario while the control group is the set of companies whose headquarters are in Quebec. All numbers are expressed in million of Canadian dollar.

Figure A3: Dynamics Treatment Effects on Within-Firm Pollution

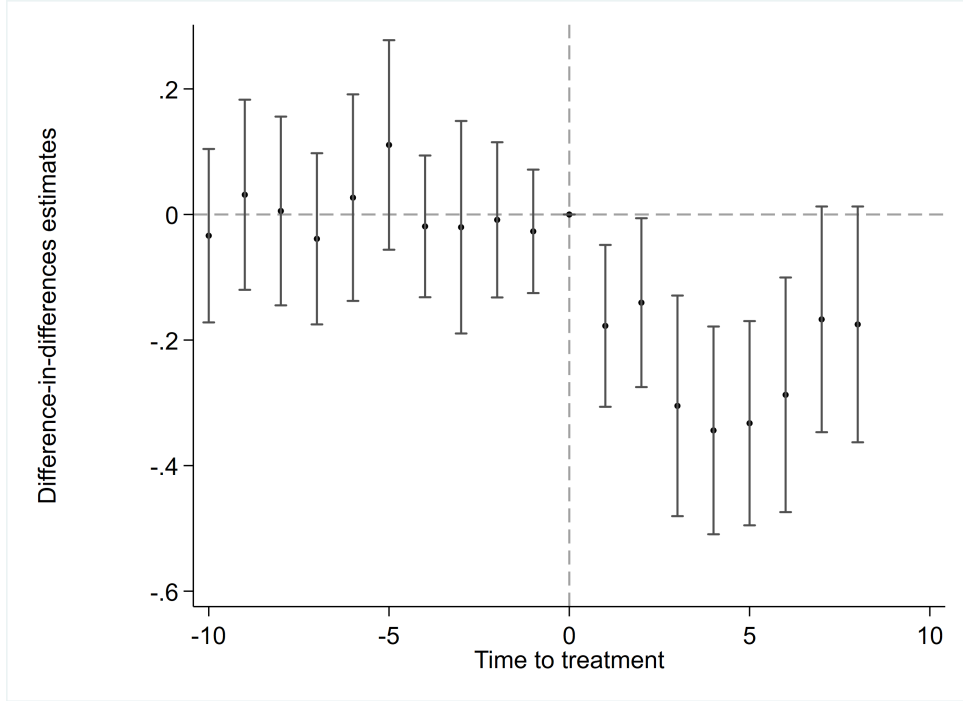


This figure reports the coefficients and confidence intervals at the 10% level of a dynamic event-study around the year of the Northstar settlement. The data is at the facility-pollutant-year level between 2010 and 2017 (included) and the reference year where $t=0$ corresponds to 2013, the year of the settlement. The treated group is the set of facilities that are located in Ontario while the control group is the set of facilities that are located in Quebec. Reported coefficients, β_k , are estimated testing the specification

$$\text{Log(Pollution}_{f,p,t}) = \sum_{k=2010, k \neq 2013}^{2017} \beta_k \text{Year}_{k,t} \times \text{Ontario}_f + \alpha_f + \alpha_{I,t} + \alpha_{c,t} + \alpha_{p,t} + \epsilon_{f,p,t}$$

where α_f are facility fixed effects, $\alpha_{I,t}$ are industry (3-digit NAICS)-year fixed-effects, $\alpha_{c,t}$ are company-year fixed effects, $\alpha_{p,t}$ are pollutant-year fixed effects. Standard errors are clustered at the province-industry (3-digit NAICS) level.

Figure A4: Dynamics Treatment Effects on Long-Term Pollution

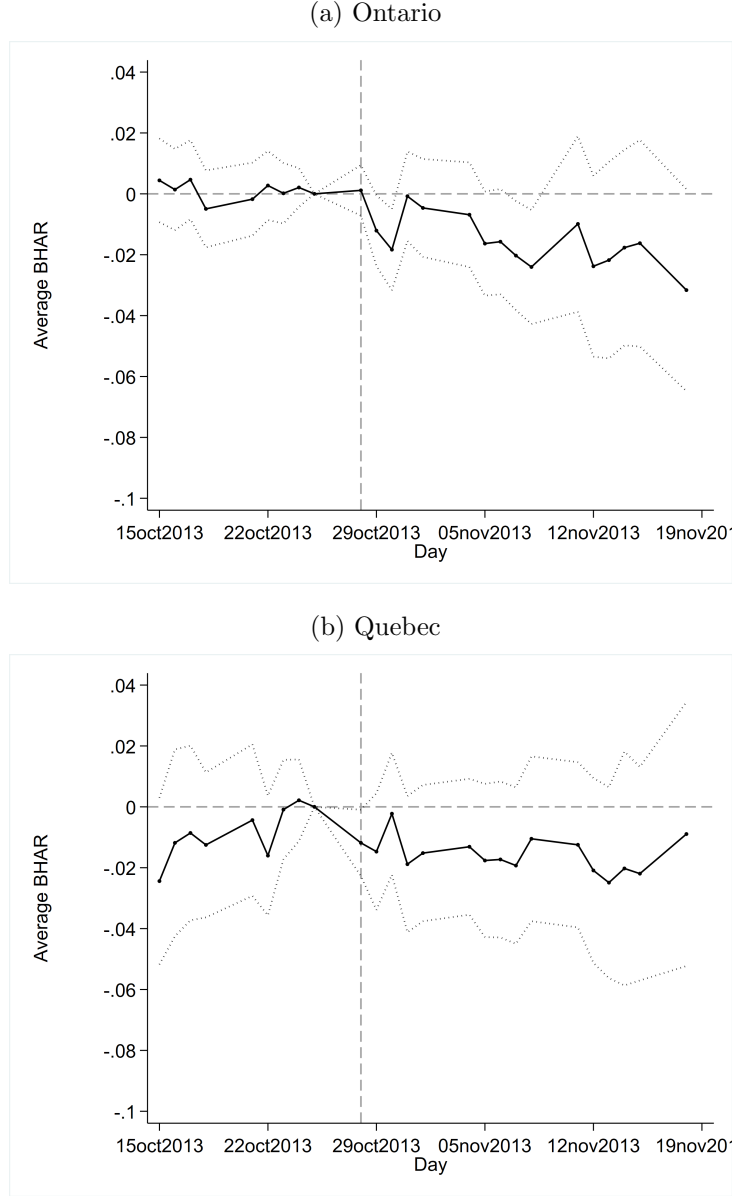


This figure reports the coefficients and confidence intervals at the 10% level of a dynamic event-study around the year of the Northstar settlement. The data is at the facility-pollutant-year level between 2003 and 2022 (included) and the reference year where $t=0$ corresponds to 2013, the year of the settlement. The treated group is the set of facilities that are located in Ontario while the control group is the set of facilities that are located in Quebec. Reported coefficients, β_k , are estimated testing the specification

$$\text{Log(Pollution}_{f,p,t}) = \sum_{k=2003, k \neq 2013}^{2022} \beta_k \text{Year}_{k,t} \times \text{Ontario}_f + \alpha_f + \alpha_{I,t} + \alpha_{p,t} + \epsilon_{f,p,t}$$

where α_f are facility fixed effects, $\alpha_{I,t}$ are industry (3-digit NAICS)-year fixed-effects, $\alpha_{p,t}$ are pollutant-year fixed effects. Standard errors are clustered at the province-industry (3-digit NAICS) level.

Figure A5: Average Abnormal Returns in Ontario and Quebec around Northstar



These figures report the daily average buy-and-hold abnormal returns (BHAR) for companies that are listed on the Toronto Stock Exchange or the Toronto Stock Exchange Venture. Firms that are considered here have their headquarters in Ontario (Panel A) or Quebec (Panel B) and belong to polluting industries (NAICS 21, 22, 31-33). BHAR at time k for company i is calculated as follows

$$\text{BHAR}_{i,[-10,k]} = \prod_{t=-10}^k (1 + r_{i,t}) - \prod_{t=-10}^k (1 + r_{m,t})$$

where $r_{i,t}$ is the return of firm i on day t , $r_{m,t}$ is the market return (TSX Composite index) on day t . Confidence intervals are computed at the 10% level. The red vertical line is the day of the Northstar settlement (October 28, 2013).

Table A1: Ex-ante Effects of Northstar on Likelihood of Directors Named in Environmental Orders in Ontario

	Individual Named
Post x Financial Distress	0.39 (0.26)
Fixed Effects	
Year	Yes
Observations	84
R-squared	0.24
Mean Sample	0.52

This table reports the effects of the Northstar case on likelihood of a director and/or executive being named in an environmental order. It reports the OLS coefficients estimated following the specification 1. The dependent variable is a dummy that equals one if a director and/or executive is named in a given environmental order. The dataset is at the environmental order level. *Post* is a dummy that equals one for years after the settlement of Northstar took place (2014-2018) and zero for the years before (2009-2013). *Financial Distress* is a dummy that equals one if the regulator considers the firm is facing financial distress or bankruptcy at the time of the issuance of the environmental order. *Individual Named* is a dummy that equals one if the environmental order named a director and/or executive. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table A2: Industry Composition in Ontario and Quebec Between 2011 and 2016

Panel A: Ontario

NAICS	Industry	Proportion in Ontario Sample
325	Chemical Manufacturing	17.07
331	Primary Metal Manufacturing	10.31
221	Utilities	9.82
212	Mining and Quarrying (Except Oil and Gas)	9.15
336	Transportation Equipment Manufacturing	9.12
332	Fabricated Metal Product Manufacturing	7.62
562	Waste Management and Remediation Services	6.12
326	Plastics and Rubber Products Manufacturing	4.09
412	Petroleum and Petroleum Products Merchant wholesalers	3.70
418	Miscellaneous Merchant Wholesalers	3.64
324	Petroleum and Coal Products Manufacturing	3.49
322	Paper Manufacturing	3.15
327	Non-metallic Mineral Product Manufacturing	2.15

Panel B: Quebec

NAICS	Industry	Proportion in Quebec Sample
322	Paper Manufacturing	14.67
325	Chemical Manufacturing	14.35
331	Primary Metal Manufacturing	10.78
212	Mining and Quarrying (Except Oil and Gas)	9.76
221	Utilities	8.97
336	Transportation Equipment Manufacturing	4.45
562	Waste Management and Remediation Services	4.28
332	Fabricated Metal Product Manufacturing	4.04
321	Wood Product Manufacturing	3.85
412	Petroleum and Petroleum Products Merchant wholesalers	3.50
324	Petroleum and Coal Products Manufacturing	3.17
326	Plastics and Rubber Products Manufacturing	3.14
418	Miscellaneous Merchant Wholesalers	2.59
327	Non-metallic Mineral Product Manufacturing	2.42
337	Furniture and Related Product Manufacturing	2.25

These tables present the industry composition for sectors that represent more than 2% of the sample in Ontario (Panel A) and Quebec (Panel B) from 2011 to 2016.

Table A3: Pollutants Most Reported in Ontario and Quebec Between 2011 and 2016

Panel A: Ontario	
Pollutant	Proportion in Ontario Sample
Zinc	5.62
Manganese	5.48
Lead	5.28
Copper	4.60
Ammonia	4.15
Xylene	3.89
Toluene	3.86
Chromium	3.82
Phosphorus	3.80
Nickel	3.52
Cadmium	3.24
Methanol	2.98
Isopropyl alcohol	2.40
Nitrate ion	2.38
Hydrochloric acid	2.34
Sulphuric acid	2.27
Arsenic	2.03
Methyl ethyl ketone	2.03

Panel B: Quebec	
Pollutant	Proportion in Quebec Sample
Ammonia	5.93
Lead	5.86
Phosphorus	5.61
Methanol	4.12
Cadmium	4.10
Zinc	3.99
Manganese	3.72
Toluene	3.48
Xylene	3.14
Arsenic	3.08
Mercury	2.95
Copper	2.73
Sulphuric acid	2.53
Isopropyl alcohol	2.41
Chromium	2.37
Hydrochloric acid	2.36
Nitrate ion	2.24
Selenium	2.24

These tables present the pollutants that represent more than 2% of the sample in Ontario (Panel A) and Quebec (Panel B) from 2011 to 2016.

Table A4: Description of Variables

Variable Name	Definition	Source
Post	An indicator equals to one for full calendar years after the Northstar settlement	NPRI/SEDAR
Ontario	An indicator equals to one for facilities located in Ontario (baseline results), or that equals one for companies whose headquarters are in Ontario (insurance result), or that equals to one for companies that own at least one facility in Ontario	
Financial Distress	A firm-level indicator equals to one for companies that are issued an order by the Ontario Ministry of the Environment because they face financial distress or are under bankruptcy protection	Registry of Ontario
Employment 2013	A firm-level indicator equals to one if the company-level number of employees in 2013 is above the median of the sample. It takes into account the number of employees in all facilities of the company that report to NPRI	NPRI
Distress 2013	A firm-level indicator equals to one if the Altman Z-score is strictly smaller than 1.81 and one if the Altman Z-score is strictly larger than 2.99	Compustat
Northstar Industry	A firm-level indicator equals to one if the company belongs to NAICS 33	Compustat
Private 2013	A firm-level indicator equals to one if the company is listed on any exchange in 2013	Compustat
1(Individual)	A firm-level indicator equals to one if the environmental order issued by the Ontario Ministry of the Environment includes at least one director and/or executives	Registry of Ontario
Total Coverage	Director and Officer liability insurance total coverage at the company-year level (covering all directors and executives of the company as a group in a given year)	SEDAR
Coverage/Director	Ratio of the Director and Officer liability insurance total coverage to the number of directors at the company-year level	SEDAR

Variable Name	Definition	Source
Total Premium	Director and Officer liability insurance total premium at the company-year level (insurance cost for all directors and executives of the company as a group in a given year)	SEDAR
Premium/Director	Ratio of the Director and Officer liability insurance total premium to the number of directors at the company-year level	SEDAR
Premium/Coverage	Ratio of the Director and Officer liability insurance total premium to the total coverage at the company-year level	SEDAR
Pollution	Pollution releases to air, water, ground at the facility-pollutant-year level. Units are expressed in tons or kgs	NPRI
1(Pollution)	A facility-pollutant-year level indicator equals to one if the facility released a given pollutant in a given year	NPRI
Hours	Number of hours of operation at the facility-year level	NPRI
Pollution/Hours	Ratio of pollution releases to air, water, ground to the annual number of hours of operation at the facility-pollutant-year level. Units are expressed in tons or kgs	NPRI
#Directors	Total number of directors at the company-year level	BoardEx
#Experts	Total number of directors who were part of an environmental-related committee at any point in their career in or before 2013 at the company-year level	BoardEx
#Experts/#Directors	Ratio of total number of directors who were part of an environmental-related committee at any point in their career in or before 2013 to the total number of directors at the company-year level	BoardEx
BHAR[0,5]	Buy-and-Hold Abnormal Returns over five business days at the company level	Compustat

Table A5: Robustness: Baseline Results with Alternative Standard Errors Clustering Levels

	Industry		Company		Facility		Pollutant	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post x Ontario	-0.21** (0.09)	-0.29** (0.14)	-0.21** (0.09)	-0.29* (0.15)	-0.21** (0.09)	-0.29** (0.12)	-0.21*** (0.05)	-0.29*** (0.11)
Fixed Effects								
Facility	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Company	-	Yes	-	Yes	-	Yes	-	Yes
Observations	29,904	28,366	29,904	28,366	29,904	28,366	29,904	28,366
R-squared	0.74	0.76	0.74	0.76	0.74	0.76	0.74	0.76

This table reports the effects of Northstar on pollution releases for standard errors clustered at the industry (NAICS 6-digit) level (columns (1)-(2)), company level (columns (3)-(4)), facility level (columns (5)-(6)), pollutant level (columns (7)-(8)). It reports the OLS coefficients estimated following the specification 2. The dependent variable is the natural logarithm of pollution at the facility-pollutant-year level. *Post* is a dummy that equals one for years after the settlement of Northstar took place (2014-2016) and zero for the years before (2011-2013). *Ontario* is a dummy that equals one for facilities located in Ontario and zero for facilities located in Quebec. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table A6: Robustness: Baseline Results for Alternative Time Periods

Panel A: 2011-2015

	Log(Pollution)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post x Ontario	-0.15*	-0.17**	-0.16**	-0.08	-0.25**	-0.23**	-0.25**	-0.23***
	(0.08)	(0.08)	(0.07)	(0.05)	(0.12)	(0.10)	(0.10)	(0.08)
Fixed Effects								
Facility	Yes	Yes	Yes	-	Yes	-	Yes	-
Year	Yes	-	-	-	-	-	-	-
Facility-Pollutant	-	-	-	Yes	-	Yes	-	Yes
Year-Pollutant	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	-	-	Yes	Yes	-	-	Yes	Yes
Year-Company	-	-	-	-	Yes	Yes	Yes	Yes
Observations	24,870	24,870	24,870	23,836	23,588	22,493	23,588	22,493
R-squared	0.62	0.75	0.75	0.95	0.76	0.97	0.76	0.97

Panel B: 2011-2017

	Log(Pollution)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post x Ontario	-0.21***	-0.24***	-0.24***	-0.12**	-0.29**	-0.23**	-0.28**	-0.22**
	(0.08)	(0.07)	(0.07)	(0.06)	(0.12)	(0.11)	(0.11)	(0.11)
Fixed Effects								
Facility	Yes	Yes	Yes	-	Yes	-	Yes	-
Year	Yes	-	-	-	-	-	-	-
Facility-Pollutant	-	-	-	Yes	-	Yes	-	Yes
Year-Pollutant	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	-	-	Yes	Yes	-	-	Yes	Yes
Year-Company	-	-	-	-	Yes	Yes	Yes	Yes
Observations	34,917	34,917	34,917	33,925	33,116	32,062	33,116	32,062
R-squared	0.61	0.74	0.74	0.94	0.76	0.96	0.76	0.96

These tables report the effects of Northstar on pollution releases for the period 2011-2015 (Panel A) and 2011-2017 (Panel B). It reports the OLS coefficients estimated following the specification 2. The dependent variable is the natural logarithm of pollution at the facility-pollutant-year level. *Post* is a dummy that equals one for years after the Northstar settlement (2014-2015 in Panel A, 2014-2017 in Panel B) and zero for years before (2011-2013). *Ontario* is a dummy that equals one for facilities located in Ontario and zero for facilities located in Quebec. Standard errors are clustered at the industry (3-digit NAICS)-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table A7: Robustness: Baseline Results for Most Reported Pollutants

	Log(Pollution)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post x Ontario	-0.22*** (0.06)	-0.22*** (0.06)	-0.20*** (0.05)	-0.13*** (0.04)	-0.25** (0.12)	-0.22* (0.12)	-0.21** (0.10)	-0.20* (0.11)
Fixed Effects								
Facility	Yes	Yes	Yes	-	Yes	-	Yes	-
Year	Yes	-	-	-	-	-	-	-
Facility-Pollutant	-	-	-	Yes	-	Yes	-	Yes
Year-Pollutant	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	-	-	Yes	Yes	-	-	Yes	Yes
Year-Company	-	-	-	-	Yes	Yes	Yes	Yes
Observations	20,242	20,242	20,242	19,725	18,634	18,066	18,634	18,066
R-squared	0.67	0.77	0.77	0.95	0.78	0.97	0.78	0.97

This table reports the effects of Northstar on pollution releases of the 21 most reported pollutants which are listed in Table A3. It reports the OLS coefficients estimated following the specification 2. The dependent variable is the natural logarithm of pollution at the facility-pollutant-year level. *Post* is a dummy that equals one for years after the Northstar settlement (2014-2016) and zero for years before (2011-2013). *Ontario* is a dummy that equals one for facilities located in Ontario. Standard errors are clustered at the industry (3-digit NAICS)-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table A8: Robustness: Baseline Results Estimated with Alternative Regression Models

Model	Log(Pollution+1)				Pollution			
	OLS				Poisson			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post x Ontario	-0.22** (0.09)	-0.22*** (0.08)	-0.19 (0.15)	-0.19 (0.15)	-0.37*** (0.13)	-0.39*** (0.14)	-0.11 (0.09)	-0.10 (0.10)
Fixed Effects								
Facility	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	-	Yes	-	Yes	-	Yes	-	Yes
Year-Company	-	-	Yes	Yes	-	-	Yes	Yes
Observations	31,493	31,493	29,928	29,928	31,344	31,344	29,739	29,739
R-squared	0.73	0.73	0.75	0.75	-	-	-	-
Pseudo R-squared	-	-	-	-	0.84	0.85	0.86	0.86

This table reports the effects of Northstar on pollution releases expressed in grams. It reports the coefficients estimated from running the OLS regression presented in Equation (2) where the dependent variable is the natural log of one plus releases at the facility-pollutant-year level in columns (1)-(2). It reports the coefficients estimated from a Poisson model where the dependent variable is the releases at the facility-pollutant-year level in columns (3)-(4). *Post* is a dummy that takes value 1 for years after the settlement of Northstar took place (2014-2016) and 0 for the years before (2011-2013). *Ontario* is a dummy that equals one for facilities located in Ontario. Standard errors are clustered at the industry (3-digit NAICS)-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table A9: Effects of Northstar on Facility-Pollutant-level Pollution by Company Ownership

Sample	Log(Pollution)				
	All Firms	Private		Public	
	(1)	(2)	(3)	(4)	(5)
Post x Ontario	-0.06 (0.12)	-0.26*** (0.10)	-0.48** (0.22)	0.02 (0.10)	-0.10 (0.14)
Post x Ontario x Private 2013	-0.19 (0.18)				
Fixed Effects					
Facility	Yes	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes
Year-Industry	Yes	Yes	Yes	Yes	Yes
Year-Company	-	-	Yes	-	Yes
Observations	27,887	16,649	15,487	11,071	10,905
R-squared	0.74	0.77	0.79	0.72	0.73

This table reports the triple-difference analysis results comparing the effects of Northstar on pollution releases for public and private companies. It reports the OLS coefficients estimated following the specification 3 where only the interactions of interest are reported in column (1) and following the specification 2 for private firms (columns (2)-(3)) and public firms (columns (4)-(5)). The dependent variable is the natural log of pollution releases at the facility-pollutant-year level. *Post* is a dummy that takes value 1 for years after the settlement of Northstar took place (2014-2016) and zero for years before (2011-2013). *Ontario* is a dummy that equals one for facilities located in Ontario. *Private 2013* is a dummy that equals one if the company is not listed on an exchange in 2013. Standard errors are clustered at the industry (3-digit NAICS)-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table A10: Robustness: Effects of Northstar on Company-level Boards with a Poisson Regression Model

	#Directors		#Experts		Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Ontario	-0.07 (0.05)	-0.09 (0.06)	-0.22*** (0.08)	-0.15* (0.08)	-0.18*** (0.05)	-0.20*** (0.04)
Fixed Effects						
Company	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	-	Yes	-	Yes	-	Yes
Year	Yes	-	Yes	-	Yes	-
Observations	551	534	193	179	187	171
Pseudo R-squared	0.46	0.47	0.25	0.27	0.07	0.08

This table reports the effects of Northstar on the number of directors on the board (columns (1)-(2)), the number of environmental expert directors on the board (columns (3)-(4)) and the ratio of environmental expert directors by the total number of directors (columns (5)-(6)). It reports the coefficients estimated from running a Poisson regression for companies that are both in the BoardEx dataset and in NPRI. The dependent variable is the number of directors in columns (1)-(2), the number of directors who had an experience on an environment-related committee in or before 2013 (columns (3)-(4)) and the ratio of the number of directors with experience on an environment-related committee by the total number of directors in a given year (columns (5)-(6)). The panel is at the company-year level. *Post* is a dummy that equals one for years following the Northstar settlement (2014-2016) and zero for years before (2011 - 2013). *Ontario* is a dummy that equals one (zero) for companies whose headquarters are in Ontario (Quebec). Standard errors are clustered at the industry-province level and reported in parentheses. The symbols *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.