Real Effects of Personal Liability: Evidence from Industrial Pollution

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Abstract

This paper studies how imposing personal liability on directors and executives can mitigate corporate environmental externalities. I use a landmark court case that increased perceptions of out-of-pocket liability risk related to corporate releases of toxic chemicals. This change varied across Canadian provinces based on their legal systems, which I exploit in a difference-in-differences analysis. I find that imposing personal liability leads to a 23% reduction in toxic chemical releases. Treated small firms scale down operations while large firms invest in clean technology. This environmental benefit is accompanied by a 2.6% decrease in abnormal returns following the shock, as well as an increase in director turnover, particularly among the wealthiest directors and environmental experts who are the most exposed to liability risk. These findings contribute to the debate on the optimal level of personal liability to regulate corporate externalities.

Keywords: Externalities, Pollution, Environmental Economics, Corporate Governance, Personal Liability, Insurance

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1 Introduction

Legal liability provides a solution to mitigate the negative externalities created by economic activity, as market participants must pay for the economic cost of the harm they cause (e.g., Kolstad et al., 1990, Shavell, 2011). This approach alters incentives and reduces corporate harm if the expected liability is sufficiently large. In practice, this may not be the case, as firms are limited liability entities, which can make them judgment-proof, undermining the effectiveness of corporate-level liability (e.g., Shavell, 1986, Boomhower, 2019, Akey et al., 2021). This paper explores whether strengthening this liability approach by introducing *personal liability* for directors and executives could be an attractive mechanism for mitigating negative corporate externalities.

There is surprisingly little evidence on how imposing personal liability can alter decision-makers' incentives and risk-taking, although it is a mechanism that is increasingly debated, particularly as a way to address environmental externalities.[1] The law and economics literature primarily outlines concerns associated with creating such liability. In particular, this mechanism could exacerbate agency costs due to excessive risk aversion among directors and executives, and devastate the director labor market by deterring skilled individuals from taking on corporate leadership roles (e.g., Kornhauser, 1982, Black et al., 2006, De Geest, 2012, Naaraayanan et al., 2021).

This paper presents new empirical evidence on the potential benefits of imposing personal liability to mitigate corporate environmental externalities, while also discussing the associated costs. Studying personal liability is generally difficult because enforcement of *out-of-pocket* personal liability is rare in North America (e.g., Black et al., 2005, Klausner, 2009, Henning, 2016). Judicial systems protect directors and executives through the business judgment rule. Corporations provide indemnification and Directors & Officers (D&O) liability insurance, which requires insurers to negotiate settlements within coverage limits. In contrast, the risk of out-of-pocket liability is higher for environmental

[1] See for example, "Ex-PGE execs to pay $117M to settle lawsuit over wildfires", *APNews*, September 29, 2022, and "Shell directors personally sued over 'flawed' climate strategy", *The Guardian*, February 9, 2023, `https://apnews.com/article/wildfires-business-fires-lawsuits-california-450c961a4c6b467fcfb5465e7b9c5ae7`, `https://www.theguardian.com/environment/2023/feb/09/shell-directors-personally-sued-over-flawed-climate-strategy`

violations for which the legal liability is said to be strict, joint and several, meaning courts provide less protection, particularly for wealthy individuals. Standard D&O insurance policies exclude environmental liability, typically offering imperfect coverage only through add-on products. Additionally, corporate indemnification is uncertain, as environmental liability often involves substantial health damages and cleanup costs.

I exploit a landmark case of enforcement of *out-of-pocket* personal liability related to corporate discharges of toxic chemicals, most of which are known to cause cancer and birth defects (e.g., Ames, 1979, Poirier, 2004). In 2013, the environmental regulator and courts in the Province of Ontario, Canada, enforced such liability for the first time in response to corporate spills of toxic chemicals in the case *Baker et al. v. Director, Ministry of the Environment*, referred to hereafter as the Northstar case. The directors and executives of Northstar Aerospace Inc. were initially charged CAD 16 million and ultimately paid CAD 5 million out of pocket to complete the remediation, as their D&O insurance did not cover pollution claims and the firm could not provide indemnification due to bankruptcy protection. This case was surprising and landmark because it was the first time regulators and courts enforced out-of-pocket personal liability for the full cleanup costs when the firm could neither cover the costs nor provide indemnification or insurance.

Thus, the Northstar case provides an unanticipated shock to the perception of out-of-pocket personal liability risk related to corporate pollution. I investigate how the increase in expected out-of-pocket personal liability affected firm outcomes in a difference-in-differences setting. I exploit that Canadian provinces have environmental legislation and have full discretion over its enforcement within their borders. Although the Provinces of Ontario and Quebec are neighbors, similar in economic size, industry composition, pollution history, and have enacted comparable environmental legislation at the same time, Ontario's enforcement of personal liability has no legal implications for Quebec's enforcement of such liability. Northstar Aerospace's directors challenged the enforcement of out-of-pocket personal liability in Ontario courts, which could have compelled Quebec to alter its enforcement of personal liability had the case been settled by the Supreme

Court of Canada. However, this did not occur, and courts in Quebec are unlikely to base their rulings on decisions from other provinces (e.g., McCormick, 1994). Therefore, I use facilities (and firms that own them) located in Ontario as the treated group and facilities located in Quebec as the control group.

I validate that the Northstar court case is a positive shock to the perception of out-of-pocket personal liability risk. First, I show that the enforcement of personal liability for illegal toxic chemical releases abruptly increased in Ontario after the Northstar case. I hand-collect environmental compliance orders issued by the Ontario environmental regulator (the Ministry of the Environment) and show that the likelihood of remediation orders involving a director and/or executive increased. Second, I show that directors and executives anticipated a higher likelihood of being held personally liable following the Northstar case. Using D&O liability insurance data reported by publicly listed firms, I find that companies in Ontario increased both their total coverage and coverage per director, compared to companies in Quebec.

The main finding of this paper is that the increase in the perception of out-of-pocket personal liability risk has substantial, statistically significant, and economically meaningful impacts on pollution outcomes. I use facility-pollutant-level pollution data provided by the National Pollutant Release Inventory (NPRI). I find that facilities operating in Ontario reduced toxic releases by 23% on average over the three years following the Northstar case, relative to facilities in Quebec and after controlling for facility characteristics and macroeconomic shocks at the industry and pollutant levels. The result remains significant and of similar magnitude even within the same company that owns facilities in both provinces.

These results on pollution are robust to several alternative specifications. First, I find no evidence of a pre-trend in average pollution before the year of the Northstar case, which is necessary for the difference-in-differences framework to be valid. Second, I find similar results for alternative pollution outcome variables that account for heterogeneity in pollutants' toxicity and the skewed distribution of pollution (e.g., Cohn et al., 2022). Third, the effect remains significant and economically meaningful when controlling for

facility-pollutant characteristics. Fourth, the effect is stronger for pollutants that are more likely to be subject to remediation orders issued by regulators.

I next investigate how facilities reduce pollution. I find that facilities reduced the amount of pollution per hour of operation (intensive margin) without significant changes in their total operating hours (extensive margin), suggesting they improved environmental efficiency (e.g., invested in cleaner technologies). Consistent with this interpretation, the response is stronger among larger companies that can afford to invest in expensive clean technologies to reduce pollution without scaling back operations. In contrast, smaller firms, which are more likely to face financial constraints, reduced operating hours without altering the pollution per hour of operation (Lanteri et al., 2023, Fang et al., 2024). I further show that my results do not reflect a simple reallocation of pollution from Ontario to other provinces. I find no reduction in Ontario facilities' annual hours of operation within a given firm relative to Quebec facilities, suggesting they did not shift production to other provinces. Moreover, the result remains strong for companies that cannot reallocate pollution across provinces – those that operate only in Ontario or Quebec.

Having established that imposing personal liability leads to a reduction in pollution, I next explore the costs associated with this mechanism. First, I examine abnormal returns and find that the stock market reacted negatively to the announcement of the Northstar case settlement. Abnormal returns decreased by an average of 2.6% in the five days following the settlement announcement for firms in the same industry as Northstar Aerospace (manufacturing), relative to other firms. This result suggests that shareholders interpret environmental personal liability as costly, likely due to expenses associated with pollution abatement, the costs of purchasing additional liability insurance, or distortions to operations and governance incurred by firms.

I next explore potential governance distortions by examining director turnover. A key concern with enforcing personal liability, as discussed in the literature and by policymakers, is the potential loss of independent directors, who play a critical monitoring role (Black et al., 2006, Bebchuk et al., 2006, Naaraayanan et al., 2021). In the context of liability for environmental outcomes, two categories of directors are of interest. First,

wealthy directors are at the greatest risk of paying out of pocket, as environmental regulators seek full payment for cleanup, and the joint and several liability regime under environmental law implies that the wealthiest directors could be held liable for the entire cost. Second, environmental expert directors face heightened legal scrutiny because their duty of care is contingent on their deeper understanding of corporate environmental risks.

I find that wealthy directors, defined as those with a net worth exceeding USD 5 million, and directors with environmental expertise, defined by their past membership on environmental-related board committees, were more likely to leave the boards of companies with at least one facility in Ontario, relative to companies without such facilities, following the Northstar case. While the loss of directors with the highest risk of out-of-pocket personal liability may undermine the disciplinary effect of personal liability, further analysis suggests that this may not be the case. I find that the reduction of pollution was concentrated in facilities owned by companies with a high ratio of wealthy directors in the year before the Northstar case, indicating that wealthy directors who remained on boards were strongly incentivized to reduce pollution. However, I find no evidence that independent directors were more likely to leave boards after the enforcement of personal liability, which contrasts with existing literature (Naaraayanan et al., 2021).

In summary, these results provide evidence on the benefits and costs of imposing personal liability to mitigate corporate environmental externalities. It leads firms to internalize some of their environmental externalities, resulting in a significant reduction in pollution, and improvements in the environmental efficiency in production. It is also associated with distortions for small firms that reduce pollution by scaling back operations. Surprisingly, I find that distortions to corporate governance are limited, as independent directors are no more likely to leave. However, wealthy directors and directors with environmental expertise—who play an uncertain role in firm value—are more likely to leave. These findings inform policymakers interested in the efficiency of personal liability as a tool to mitigate corporate externalities.

This paper contributes to the literature on mechanisms to mitigate environmental

externalities. The premise is that no legal or regulatory mechanism needs to be invoked if there are no transaction costs involved (Coase, 1960). With transaction costs, corporate-level liability is efficient in minimizing harmful activities (e.g., Shavell, 2011) but, in practice, corporations are limited liability entities and can mitigate tort liabilities through bankruptcy (e.g., Resnick, 1999, Boomhower, 2019, Akey et al., 2021, Bellon, 2021, Chen, 2022, Ohlrogge, 2022). Firms can also strategically respond to liability by engaging in greenwashing rather than improving environmental outcomes (e.g., Duchin et al., 2022), or they may be constrained and not respond (e.g., Alberini et al., 2002, Xu et al., 2022, Bellon et al., 2024). Other mechanisms include the use of corrective taxes (e.g., Sandmo, 1975), but they lead to inefficiencies in theory (e.g., Shavell, 2011) and their implementation in practice is often problematic (e.g., Baumol et al., 1971, Aldy et al., 2010, Goulder et al., 2008, Victor et al., 2017, Maestre-Andrés et al., 2019). Cap-and-trade systems, managerial compensation tied to pollution-related metrics, and shareholder engagement or capital allocation are other mechanisms; however, their effects on environmental outcomes remain unclear (e.g., Flammer et al., 2016, Bartram et al., 2022, Bebchuk et al., 2022, Michaely et al., 2024). The approach in this paper, in contrast, focuses on personal liability. I contribute to the literature by quantifying the impact of this mechanism in mitigating environmental externalities, showing that personal liability leads firms to improve environmental efficiency, albeit with some distortions.

Second, this paper contributes to the literature on personal liability for directors. It provides new evidence on the benefits of imposing personal liability in deterring corporate externalities while also documenting some of the costs. Out-of-pocket personal liability is historically rare for corporate and securities fraud (e.g., Black et al., 2005, Klausner, 2009), which makes it challenging to study both the costs and benefits of this mechanism.[2] Thus, the literature studying the effects of personal liability on corporate

[2]The empirical strategies commonly used in the literature do not account for the enforcement of out-of-pocket personal liability and changes in the perception of directors' personal liability risk. For instance, Donelson et al., 2019, Koudijs et al., 2020, Koudijs et al., 2021, Naaraayanan et al., 2021, Ivanova et al., 2022 study legislation changes in personal liability. Brook et al., 1994, Bradley et al., 2011, Aguir et al., 2014, Aguir et al., 2020 study variations in personal liability as stated in companies' charters. Lin et al., 2019 study the introduction of an out-of-pocket personal deductible in the D&O liability insurance contracts.

outcomes remains limited, focusing primarily on settings in India (Naaraayanan et al., 2021) and Sweden (Ivanova et al., 2022), where the main findings indicate that firm value and corporate governance are negatively affected by such liability.

The rest of the paper is organized as follows. Section 2 presents institutional background on Canadian environmental law and the importance of the Northstar case. Section 3 describes the datasets and samples. Section 4 describes the empirical strategy and Section 5 shows the effects on pollution. Section 6 studies the effect on firm performance and Section 7 explores developments in the director labor market. Section 8 provides further discussion and Section 9 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, with provincial governments having the most influence. While the federal government determines environmental disclosures (e.g., the NPRI which provides facility-pollutant-level pollution data, used in this study) and sets standards for environmental legislation, it is at the provincial level that laws are enacted for management of natural resources, restriction on the use of pollutants, and 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.[3]

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. 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.[4] 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.[5] 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.[6] 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, courts have rarely used strict liability provisions. When they are, corporations usually pay for expenses. Out-of-pocket personal liability for environmental

[3]The Ontario 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.

[4]Congress 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.

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

[6]Precisely, 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.

misconduct was enforced in Ontario only once before the Northstar case in *R. v. Bata Industries Ltd., Marchant and Weston* (1992) and the fines were negligible.[7]

Importantly, the legal concept of joint and several liability applies in Ontario environmental law. This means all defendants are liable for the damage, without dividing responsibility among them. The plaintiff can request full payment from any or all defendants without losing out on the total amount. In practice, this incentivizes wealthy directors and executives to settle, as they could be responsible for the entire remediation cost.

In the Northstar case, the environmental regulator used the personal liability provision of the EPA to issue an order for full remediation against the company's directors and executives. The regulator targeted these directors and executives because the company was shielded from remediation liability due to its bankruptcy.

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.[8] 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.[9]

Most D&O insurance contracts exclude pollution claims. The main reason is that pol-

[7]For an analysis of the case, see "Whatever Happened To... The Bata Shoe Company", January 2012, `https://prism.ucalgary.ca/server/api/core/bitstreams/08545f90-50e6-43ca-b19e-2fc9e786a119/content`. 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.

[8]Under 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.

[9]Precisely, 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."

lution 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 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 (e.g., Agrium Inc, Wesdome Gold Mine) and firms that specify not having pollution insurance included in their D&O liability insurance(e.g., 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.[10] Because Quebec operates under a civil law system, the persuasive authority of Ontario courts is limited in Quebec, unlike in other provinces. The empirical strategy in this study exploits these differences in legal treatment across provinces..

[INSERT FIGURE 1 HERE]

2.2 Northstar as Landmark

2.2.1 The Northstar Case

The shock this paper exploits to identify the impact of personal liability on environmental outcomes is called 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

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

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 under bankruptcy law, the MOE was left in charge of paying for remediation.[11]

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 directors immediately appealed the decision, but the appeal was later 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.[12] The settlement was approved and made public by the Ontario court on the same day.

In the analysis, I consider October 28, 2013, as the key date enforcement of out-of-pocket personal liability began for the Northstar directors. I do not consider the date of the issuance of the orders (November 2012) because orders naming directors and/or executives are not specific to the case and were subject to immediate appeal. The key aspect in this case is that the appeals were dismissed by the bankruptcy court and the Ontario court and led to a settlement between directors and the regulator.

The enforcement of personal liability by the environmental regulator and Ontario

[11]Seniority 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.

[12]This represents about a third of the total remediation cost that the regulator sought from the company and, later, the directors. It is a significant amount for each individual director. 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.

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.[13] 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."

2.2.2 No Evidence of Concurrent Environmental Regulatory Enforcement

In this study, I use the Northstar case to identify how shifts in the perception of personal liability risk affect environmental outcomes. Other factors that could influence these environmental outcomes include new environmental regulations or increased enforcement of existing regulations by the MOE. For instance, the federal Chemicals Management Plan was amended in 2012 and implemented in 2013. Although this regulation affects all provinces equally and should not be a major concern, I exclude pollutants that were impacted by it.

Regarding enforcement activity by the MOE, the number of inspections remains constant, and operating budgets do not significantly increase. The MOE reports 8,794 inspections in 2012-2013, 8,900 in 2013-2014, 8,800 in 2014-2015, 8,200 in 2015-2016. As for operating budgets that cover enforcement of environmental regulation, they report CAD 322 million in 2013-2014, CAD 323 million in 2014-2015, CAD 326 million in 2015-2016.[14]

[13]For example, see "Former Northstar directors, officers reach deal with Ontario over cleanup", *The Globe and Mail*, October 28, 2013, https://www.theglobeandmail.com/report-on-business/industry-news/the-law-page/former-northstar-directors-officers-reach-deal-with-ontario-over-cleanup/article15125063/, and "Last Directors Standing: Expanding the Scope of Directors' and Officers' Environmental Liability in the Northstar Aerospace Case", *McCarthy Tetrault*, November 10, 2013, 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/

[14]Reports can be found on https://www.ontario.ca/page/all-published-plans-and-annual-

2.2.3 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 the percentage of orders naming a director and/or executive. First, I hand-collect (publicly available) all orders issued by the Ontario MOE to companies between 2009 and 2018 (84 orders). Figure 2 shows that the proportion of environmental orders that name directors and/or executives increases significantly over time after Northstar. After 2013, about 70% of the orders name directors and/or executives, whereas, prior to 2012, 25% to 50% of the orders named directors and/or executives.[15]

[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

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

where a company c receives an environmental order in year t. *1(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. *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. Standard errors are robust.

I show in Table A1 in the Appendix that the probability of an order naming a director and/or executive increases significantly following Northstar. Moreover, the increase is larger for companies facing financial distress (or under bankruptcy protection) compared

`reports`

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

to those that are not. This finding suggests that the regulator was more likely to name directors and executives in environmental orders after 2013, especially when the firm was facing financial distress. In other words, Northstar did affect the likelihood of personal liability.

3 Sample and Descriptive Statistics

3.1 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.[16] 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 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

[16]For 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. For more details on reporting requirements, see `https://publications.gc.ca/site/eng/9.506026/publication.html`

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 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).[17]

3.1.1 Company-Level Data

Publicly listed companies in Canada generally disclose their Director and Officer liability insurance's annual coverage, premium, and deductible in management proxy circulars.[18][19] Coverage refers to the maximum total amount that 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), my sample includes 98 companies reporting their annual insurance coverage and premiums (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.[20]

Financial information and stock prices at the company level (for public firms) are from Compustat. 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 operate at least one facility in Ontario while 63 do not operate any facility in Ontario (any other province than Ontario is considered for the control group for these tests). [21]

[17] In 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.

[18] Publicly listed companies in Canada were required by law to disclose their Director and Officer liability insurance until 2004 and encouraged to disclose after 2004. In general, firms would not stop disclosing their insurance.

[19] Management proxy circulars are available on SEDAR, the Canadian equivalent of EDGAR, an online database used by public companies in Canada to file mandatory documents with securities regulators.

[20] A 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.

[21] Because BoardEx covers private firms as well as public firms, the average board is smaller in terms of number of directors than the average board in the D&O liability insurance data.

I use BoardEx to proxy directors' environmental expertise, wealth, independence, and education. I hand-code an environmental expertise dummy variable, which equals one if a director ever served on an environmentally related committee before 2013, at any company. Additionally, I hand-code a wealth dummy variable that equals one if a director is listed by Wealth-X (available in BoardEx) as having a net worth exceeding USD 5 million. Furthermore, I hand-code an education dummy variable that equals one if a director attended an Ivy League school (Harvard, Princeton, Yale, Columbia, University of Pennsylvania, Cornell, Brown, or Dartmouth) or obtained a postgraduate degree (e.g., executive programs, professional certificates), as suggested in the literature (e.g., Cassel et al., 2023).

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 A5 in the Appendix describes all outcome and independent variables used in the analysis.

[INSERT TABLE 1 HERE]

4 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.

4.1 Facility-pollutant-level Regression Specifications

My empirical strategy relies on comparing treated Ontario facilities with control Quebec facilities. I define a treatment dummy *Ontario* that equals one for facilities that are located in Ontario and zero for facilities located in Quebec. 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

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

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.

I also introduce a more stringent specification which controls for time-variant changes at the company level and 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.[22] 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 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).

[22] This accounts for about one third of the sample.

In later tests, I study the heterogeneity in responses following Northstar using the same specification. First, I conjecture that the firms that react the most to Northstar are those where directors and executives are wealthy, as the regulator names them in environmental orders only if they have the ability to pay.[23] I conduct a triple-difference analysis using firms with a low ratio of wealthy directors in the year before the Northstar settlement, 2012, as the benchmark group. I also conduct a placebo test where, instead of using the ratio of wealthy directors, I use the ratio of educated directors on the board (e.g., directors who graduated from an Ivy League school or obtained a postgraduate degree). I estimate the following specification:

$$\begin{aligned} Log(\text{Pollution}_{p,f,c,t}) = \beta_1 \text{Post}_t \text{x Ontario}_f + \\ \beta_2 \text{Post}_t \text{x Ontario}_f \text{x Ratio Wealthy 2012}_c + \alpha_f + \alpha_{I,t} + \alpha_{p,t} + \epsilon_{p,f,c,t} \end{aligned} \tag{3}$$

where only the interaction terms of interest are written down. *Post* and *Ontario* are defined as above. *Ratio Wealthy 2012* is a continuous variable that equals the 2012 ratio of the number of wealthy directors to the total number of directors. In a placebo test, I use the ratio of educated directors where I measure education in two ways. I define two continuous variables, *Ratio Top School 2012* and *Ratio Postgraduate 2012*, that equal, respectively, the 2012 ratio of the number of directors who graduated from an Ivy League school and those who obtained a postgraduate degree to the total number of directors. This specification includes the same fixed effects as in the main specification and standard errors are clustered at the industry (facility NAICS 6-digit) level.

In a second heterogeneity test, I investigate how the response following Northstar differs based on company-level size and financial distress. On the one hand, financially constrained firms may react more because directors and executives are more likely to be personally liable if the firm cannot pay for remediation. On the other hand, these firms may lack the resources to invest in pollution remediation or prevention. The objective

[23] I argue that this is first-order due to the legal principle of joint and several liability discussed above. Moreover, even if the firm is not facing financial distress, remediation claims from the regulator or lawsuits from private parties for environmental and human health damage can be substantial, potentially putting financially healthy firms in a state of financial distress.

of this test is to determine which force is stronger. I conduct the same analysis as in the main specification for two subsamples splitted based on 1) the 2012 company-level employment median for all firms of the sample, and 2) the 2012 Altman Z-score for public firms.

4.2 Company-level Regression Specifications

To test whether Northstar impacted D&O liability insurance outcomes, stock market reaction and labor market outcomes, I also conduct company-level tests. 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.[24] 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.[25] I estimate the difference-in-differences specification

$$Y_{c,t} = \beta \text{Post}_t \text{x Ontario}_c + \alpha_c + \alpha_t + \epsilon_{c,t} \tag{4}$$

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. Standard errors are clustered at the industry level.

To study the effects of Northstar on liability insurance, I consider the outcome $Y_{c,t}$ to be the D&O liability insurance total coverage or the D&O liability insurance coverage per director.

I conduct the same analysis considering director variables such as the ratio of the total number of directors who leave the board to the total number of directors, and the ratio of the number of directors who are wealthy or independent to the total number of directors.

Finally, I study the stock market reaction following the announcement of the Northstar

[24]This 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.

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

settlement for firms whose headquarters are located in Ontario. I estimate the difference-in-differences specification

$$\text{BHAR[0,k]}_c = \beta \mathbf{1}_{[\text{Northstar}]c} + \text{BHAR[-15,-1]}_c + \epsilon_c \tag{5}$$

where the dependent variable is the Buy-and-Hold Abnormal Returns over $k \in \{2, 5, 10\}$ days following the day of the Northstar settlement (October 28, 2013) for firm c. It is computed as follows

$\text{BHAR[0,k]}_c = \prod_{t=0}^{k} (1 + r_{c,t}) - \prod_{t=0}^{k} (1 + r_{m,t})$ (6) where $r_{c,t}$ is the return of firm c on day t and $r_{m,t}$ is the market return (TSX Composite index) on day t. The independent variable *Northstar* is a dummy variable that equals one for firms in the manufacturing industry to which Northstar belonged (NAICS 33). The specification includes past buy-and-hold abnormal returns over the previous 15 days to control for momentum and persistence in returns. Standard errors are robust.

5 Results

5.1 Did the Northstar Case Change Perceptions of Personal Liability Risk?

To validate Northstar as a shift in the perception of personal liability risk by companies, I test whether companies increased their D&O liability insurance coverage following the Northstar case.

Table 2 shows the results following the estimation of the difference-in-differences specification (4). The outcome variables are the total coverage (columns (1)-(2)) and the ratio of the total coverage to the number of directors (columns (3)-(4)). Companies whose headquarters are in Ontario increased their D&O liability insurance total coverage and the ratio of the total coverage to the number of directors on their boards following the Northstar case. The coefficients are significant at the 1% level (columns (1) and (3))

when considering company and year fixed effects, and at the 10% level (columns (2) and (4)) when including year-industry fixed effects.

Results indicate that total coverage increased within company by an average of 9.87 to 15.79 million Canadian dollars (columns (1)-(2)) and 1.11 to 1.96 million Canadian dollars per director following Northstar (column (3)-(4)). In terms of economic magnitude, these estimates reflect average increases in coverage ranging from 11% to 18% relative to the mean, and average increases in coverage per director ranging from 12% to 22%.[26]

[INSERT TABLE 2 HERE]

To ensure that the changes in D&O liability insurance coverage can be attributed to the Northstar case, I verify that there are no significant differences in average insurance coverage between the treated and control companies before 2013. Figure 3 plots the coefficients for the dynamic event study, using the year of the Northstar settlement, 2013, as the reference year. The OLS coefficients are around zero before 2013 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.

[INSERT FIGURE 3 HERE]

These findings suggest that companies in Ontario viewed the Northstar case as reflecting stricter enforcement of personal liability by the Ontario environmental regulator. They support using the Northstar case as a positive shock to the perception of personal liability risk.

[26] In unreported analysis, I find that the total premium increased by an average of 60,000 Canadian dollars, which represents a 13% increase relative to the mean. The coefficient is significant at the 10% level when considering company and year fixed effects.

5.2 Baseline Results

I test whether the enforcement of personal liability for directors and executives alters corporate releases of toxic chemicals. The underlying assumption is that D&O liability insurance does not fully cover pollution liability. Here, I provide some estimates of how much facilities reduce pollution, given that some of the personal liability risk may be hedged with insurance.

In Table 3, I show that enforcement of personal liability has substantial positive impact on pollution reduction. I estimate the difference-in-differences specification (2) where the dependent 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 by an average of 23% (exp(0.21)) relative to pollution in Quebec within three years following Northstar, within facility and controlling for trends at the industry (facility NAICS 3-digit) and pollutant level. It is statistically significant at the 1% level (column (3)).

In further tests (columns (5)-(8)), I find that, among facilities that belong to the same firms, pollution in Ontario decreased by an average of 33% (exp(0.286)) relative to pollution in Quebec within three years following Northstar, within facility and controlling for trends at the industry (facility NAICS 3-digit) and pollutant level. It is statistically significant at the 1% level (columns (7)).[27]

Table 3 also reports the OLS coefficients estimated from including facility-pollutant fixed effects which control for factors that are unique to a given facility and pollutant (e.g., production process). The estimates are significant and indicate an average decrease in pollution in Ontario of 11% relative to pollution in Quebec within three years following Northstar, within facility-pollutant and controlling for industry (facility NAICS 3-digit) and pollutant trends (column (4)). When conducting the analysis within firm, I find an average decrease in pollution in Ontario of 25% (exp(0.24)) relative to pollution in Quebec within three years following Northstar, within facility-pollutant and controlling

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

for industry and pollutant trends (column (8)).

[INSERT TABLE 3 HERE]

To ensure that the reduction in pollution can be attributed to Northstar, I verify that there is no preexisting differences in average pollution between the treated and control facilities before 2013. Figure 4 plots the coefficients for the dynamic event-study using the year of the Northstar settlement, 2013, as the reference year. The OLS coefficients are around zero before 2013 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 A2 in the Appendix plots the dynamics for the specification that includes company-year fixed effects. Figure A3 in the Appendix plots the long-term dynamics.

[INSERT FIGURE 4 HERE]

I conduct several robustness checks that are presented in the Appendix. In Table A6, I show that the baseline results hold when standard errors are clustered at the industry (facility NAICS 6-digit), company, facility, or pollutant levels. In Table A7, I report the results for a shorter sample period (2011-2015 in Panel A) and a longer sample period (2011-2017 in Panel B). In Table A8, I report the baseline results for alternative outcome variables. Pollutants vary in their toxicity and the reported releases are non-negative, skewed and concentrated near zero values. First, I consider the percentile rank of a given facility-pollutant pair changes within Canada. Second, I consider the outcome variable that is sometimes used in the literature, that is the logarithm of toxic releases in kilograms plus one (e.g., Akey et al., 2021, Bellon, 2021). Last, I estimate the baseline specification (2) using a Poisson model (instead of OLS) following Cohn et al., 2022.

Table 4 presents the baseline results for the pollutants that are the most reported by facilities in Quebec and Ontario (listed in Table A3 in the Appendix) and the pollutants

that are mentioned in environmental orders issued by the Ministry of Environment of Ontario. The coefficient estimates are of an economic magnitude similar to that of the full sample for the most commonly reported pollutants. The coefficient estimates are higher for environmental orders' pollutants. This shows that the baseline results are not driven by outlier pollutants and that the enforcement of personal liability has an impact on the most harmful pollutants.

[INSERT TABLE 4 HERE]

5.3 How did Facilities Reduce Pollution?

Next, I study how facilities reduced pollution. I investigate whether they reduced pollution in the extensive margin (e.g., reducing production), in the intensive margin improving the environmental efficiency of their production processes (e.g., investing into cleaner technology, improving monitoring) and to what extent they may reallocate pollution to other Canadian provinces.

Table 5 presents the results. I study the effects of the Northstar case on the presence of pollutants reported by facilities where 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)), the annual number of hours facilities operate for (columns (4)-(6)) and the ratio of pollution to the hours of operation (columns (7)-(9)).

I find that facilities mainly reduced pollution in the intensive margin. I do not find evidence that facilities changed the composition of pollutants they used (columns (1)-(3)) or decreased their annual hours of operation (columns (4)-(6)). The ratio of pollution to the annual hours of operation of facilities in Ontario decreased by an average of 19% (exp(0.18))) relative to facilities in Quebec within the three years following the Northstar case, within facility and controlling for trends at the industry (facility NAICS 3-digit) and pollutant level. This estimate is statistically significant at the 1% level (column (7)). Estimates indicate that this result holds when comparing treated and control facilities that belong to the same firm and the effect ranges from 12% to 16% (column (8)-(9)). These results suggest that facilities decreased pollution intensity following the Northstar case

which can be interpreted as an investment into clener production technologies, pollution abatement devices, greater monitoring.

[INSERT TABLE 5 HERE]

Last, I investigate to what extent facilities reallocate pollution to other provinces. I estimate the baseline specification (2) focusing on the subsample of firms that could not reallocate pollution as they did not own facilities in both provinces Ontario and Quebec throughout the full sample period. Table A9 in the Appendix presents the results. Facilities in Ontario that did not have sister facilities in Quebec (owned by the same firm) reduced pollution by 14% relative to facilities in Quebec that did not have sister facilities in Ontario within the three years following the Northstar case (column (2)). The average reduction was 12% for the companies that owned a unique facility in Ontario relative to companies that owned a unique facility in Quebec. These results, when compared to the baseline results, suggest that the main effect is not explained by reallocation although some may occur.

5.4 Heterogeneity

I explore heterogeneity in the baseline results, focusing on two factors that may influence firms' responses to personal liability enforcement. First, I investigate the role of firms' financial constraints Second, I investigate how the boards' directors' characteristics matter.

5.4.1 Firms' Size and Z-Score

First, I test how firms' size matters in the response to the Northstar case. I use company-level employment data from the NPRI database as a proxy for financial constraints (larger firms may be less constrained). I define firms as small if their number of employees in 2012 was lower than the median company-level employee count for that year, and as large if it exceeded the median. A priori, it is unclear how firms' financial resources will affect their reduction in pollution. Firms with fewer financial resources may face greater risks of

financial distress once they are liable for environmental misconduct, potentially triggering the use of the personal liability provision. On the other hand, reducing pollution is costly, and financially constrained firms may not be able to afford it.

Table 6 presents the results. I find that large firms reduced pollution following the Northstar case while small firms did not (columns (1)-(3)). This is consistent with the idea that pollution mitigation is a costly investment for firms. Investigating this further, I analyze margins of response for small and large firms (columns (4)-(9)). I find some evidence that facilities owned by small firms, which are potentially more financially constrained, reduced their annual hours of operation, which may be a cheaper way to reduce pollution (column (4)-(6)).On the other hand, the facilities that are owned by large firms responded in the intensive margin (column (9)), which necessitates financial resources.

[INSERT TABLE 6 HERE]

In Table A10 in the Appendix, I use the company-level Altman Z-score, which I compute from Compustat financial data, as a proxy for expected financial distress. I define firms as financially distressed if their Altman Z-score in 2012 was strictly lower than 1.81 and as financially healthy if it was strictly higher than 2.99, as defined in the literature (Altman, 1968). The results are consistent with the findings resulting from the split based on firms' size. The facilities of financially healthy companies reduced pollution (column (2)) while the facilities of distressed firms did not (column (1)). Exploring margins, I find that healthy firms' facilities reduced pollution intensity while distressed firms' facilities did not.

Overall, these findings are consistent with the idea that investment in reducing pollution is costly and that financially constrained firms may not have the resources to invest in pollution reduction.

5.4.2 Boards' Characteristics

Second, I test whether characteristics of boards' drive the reduction in pollution. Wealthy directors are more likely to be held liable as the legal principle of joint and several liability holds under the Ontario environmental law, meaning the richest individuals may be liable

for the full liability. This provision seeks to compensate victims by holding any financially capable director liable for the damage, regardless of their individual responsibility. I conjecture that companies with wealthy directors on their boards will respond more strongly than those without. Moreover, directors with environmental expertise may face a higher legal scrutiny as their duty of care is contingent on their skills and the information they have about the firms' environmental risks.

In Table 7, I show in a triple-difference analysis that the baseline results are driven by companies with wealthy directors. The difference in the reduction of pollution between companies with more wealthy directors on their boards and companies with less of them is significant at the 5% level (column (1)). This finding is consistent with the idea that regulators or plaintiffs may pursue personal liability only when they can seek compensation, which occurs if directors or executives are wealthy, providing the latter with greater incentives to reduce pollution. These findings hold when controlling for the expertise, education, and independent of the directors (columns (4)-(5)). Moreover, I do not find evidence that boards with more expert directors significantly reduce pollution (column (2)).

[INSERT TABLE 7 HERE]

6 Stock Market's Reaction to the Northstar case

Next, I investigae the potential costs associated with the enforcement of out-of-pocket personal liability. First, I test how the stock market reacted following the announcement of the out-of-pocket settlement between the directors of the Northstar Aerospace's company and the Ministry of the Environment of Ontario. Personal liability is a cost that is applied directly to directors and executives rather than to the corporation and its shareholders, suggesting the market may not perceive it as negatively impacting shareholder value. However, there may be indirect costs that spill over to the corporation.

I compute the buy-and-hold abnormal returns (BHARs) around the announcement of the Northstar case's settlement which occurred on October 28, 2013. The Ontario Land

Tribunal approved the settlement at a hearing and national newspapers reported it on the same day (e.g., McFarland, 2013).[28]

Table 8 presents the coefficients estimated from the difference-in-differences specification 5. I show that the stock market reacted negatively to the announcement of enforcement of out-of-pocket personal liability. Companies in the manufacturing industry experienced negative abnormal returns that were 2.1% lower than that of other industries over two days (columns (1)-(2)), and 2.6% basis points lower over five days (columns (3)-(4)). This specification controls for persistence in returns (abnormal returns in the 15 days before the announcement) and the coefficients are significant at the 5% and 10% levels, respectively. Although the underperformance is not statistically significant over ten days, it remains negative and of the same magnitude (columns (5)-(6)). This indicates that no market reversal occurred within the ten-day period.

[INSERT TABLE 8 HERE]

Figure 5 plots the average BHARs for companies that were the most affected by the shock, which are those whose headquarters are in Ontario and operate within the manufacturing industry (NAICS-33) which is the industry Northstar Aerospace Inc. operated in. It shows that the announcement of the settlement led to a sharp decline in average BHARs, relative to the day before the announcement. This suggests that the stock market perceived the announcement of the settlement as negative to shareholder value. Figure A4 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.

[INSERT FIGURE 5 HERE]

This result can be interpreted as shareholders anticipating that firms will spend more investing in pollution mitigation and liability insurance, or will suffer from board turnover

[28]I use the settlement date announcement rather than the order issuance date in November 2012 because orders naming directors and executives occurred before Northstar and generally do not result in out-of-pocket liability. Moreover, in the Northstar case, the orders were appealed immediately.

following the enforcement of out-of-pocket personal liability. I provide suggestive evidence on board turnover in the next section.

7 Effects of Northstar on Board Turnover

Next, I explore how the Northstar case affected the size and composition of boards. The most prominent concern when imposing personal liability on directors and executives is that they will leave corporate boards (Black et al., 2006, Bebchuk et al., 2006, Naaraayanan et al., 2021).

To provide insight into these questions, I merge the NPRI and BoardEx datasets to obtain information on the locations of the facilities of companies where directors serve.[29] I conjecture that directors who serve on boards of firms that operate at least one facility in Ontario perceive a higher risk of personal liability for poor environmental outcomes following Northstar and may leave boards of affected companies. Of course, additional D&O liability insurance coverage and increase in compensation are factors that may mitigate the increased risk and reduce the effects that we may observe boards. However, D&O liability insurance contracts often include exclusions for pollution claims, or it may be very expensive to cover pollution claims, as they can result in very high settlements. Compensation is also unlikely to fully hedge against the increased liability risk for environmental misconduct.

The corporate governance literature has highlighted the key role of independent directors in improving firm value (e.g., Kaplan et al., 1990, Duchin et al., 2010, Nguyen et al., 2010). In the context of environmental liability, two types of directors are more exposed to increased personal liability risk: wealthy directors who may have to bear the full liability for corporate environmental misconduct and directors who have environmental expertise and possess more information about firms' environmental risks.

[29] Hence, I focus on directors who serve on boards of polluting companies and are all potentially affected by the increased personal liability risk following Northstar. The only difference in exposure is whether their firms operate or not a facility in Ontario.

7.1 Independent and Wealthy Directors

In Table 9, I show that wealthy directors are more likely to leave boards following Northstar. On the other hand, I do not find evidence that independent directors leave boards following Northstar. The dependent variable is defined as in Naaraayanan et al., 2021. It is the ratio of the number of independent (wealthy) directors who leave the boards to the total number of directors in a given year.

I find that the ratio of directors leaving boards of companies that own at least one facility in Ontario increases by an average of 0.07 to 0.09 in three years relative to companies that do not own any facility in Ontario, following Northstar. Coefficients are significant at the 5% level (columns (1)-(2)). The coefficient for the ratio of independent directors leaving boards is statistically indistinguishable from zero. The ratio of wealthy directors leaving boards of companies that own at least one facility in Ontario increases by an average of 0.04 to 0.05 in three years relative to companies that do not own any facility in Ontario, following Northstar. Coefficients are significant at the 10 and 5% levels (columns (5)-(6)). In Table A12, I consider the dependent variable being the ratio of independent (wealthy) directors leaving the board to the ratio of independent (wealthy) directors serving on the board. I find similar results.

These results provide suggestive evidence that the enforcement of personal liability for directors may cause wealthy directors to leave boards, but not necessarily independent directors.

[INSERT TABLE 9 HERE]

7.2 Environmental Expert Directors

In Table 10, I find that the size of the boards does not significantly shrink (columns (1)-(2)) but the number of environmental expert directors does (columns (3)-(4)) following Northstar. 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. I find that companies that own at least one facility in Ontario experienced

a significant reduction in the number of environmental expert directors relative to companies who do not own any facility in Ontario following Northstar. The magnitude of the effect ranges from 19% (0.23/1.2) to 32% (0.39/1.2) and is significant at the 1% level when including year-industry fixed effects. I also find that the representation of environmental expert directors on boards decreases by an average of 13% (0.02/0.15) to 26% (0.04/0.15) following Northstar. These results are consistent with the fact that environmental expert directors have more information about the firms' environmental risks and may perceive higher personal liability risk if the corporation faces environmental litigations.

[INSERT TABLE 10 HERE]

To ensure that the finding on environmental expert directors leaving boards can be attributed to Northstar, I verify that there is no preexisting differences in average number of expert directors between the treated and control companies before 2013. Figure 6 plots the coefficients for the dynamic event-study using the year of the Northstar settlement, 2013, as the reference year. The OLS coefficients are around zero before 2013 and indicate that there is no significant difference in the average number of expert directors between companies that own at least one facility in Ontario and companies 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 6 HERE]

8 Discussion

This study has important policy implications for environmental policy. Results indicate that enforcing personal liability for poor corporate environmental outcomes leads to significant social benefits, particularly in terms of reducing pollution. There may be associated costs for corporations as they invest in pollution mitigation. From a policy-maker's perspective, it is difficult to determine whether these are costs to society as well,

since it depends on how close corporate investments in pollution mitigation before the enforcement of personal liability were to optimal levels. In other words, it is hard to say whether personal liability leads to excessive investment in pollution mitigation.

Historically, policymakers and academics have considered one of the major social costs associated with personal liability to be its impact on corporate governance. Specifically, the main concern is that it could reduce the pool of directors willing to serve on corporate boards, particularly those who are the most talented and valuable to firms and society, such as independent directors. This study provides suggestive evidence that environmental expert and wealthy directors may be less willing to serve on boards, but it finds no evidence that independent directors are similarly affected. While the loss of environmental expert directors and wealthy directors may have negative consequences for society, these results suggest that the corporate governance costs associated with personal liability may not be as significant as one might expect. Of course, there may be other welfare effects that I do not observe or account for in this analysis, which primarily aims to highlight the large social benefits and inform about some of the more direct costs that might come to mind.

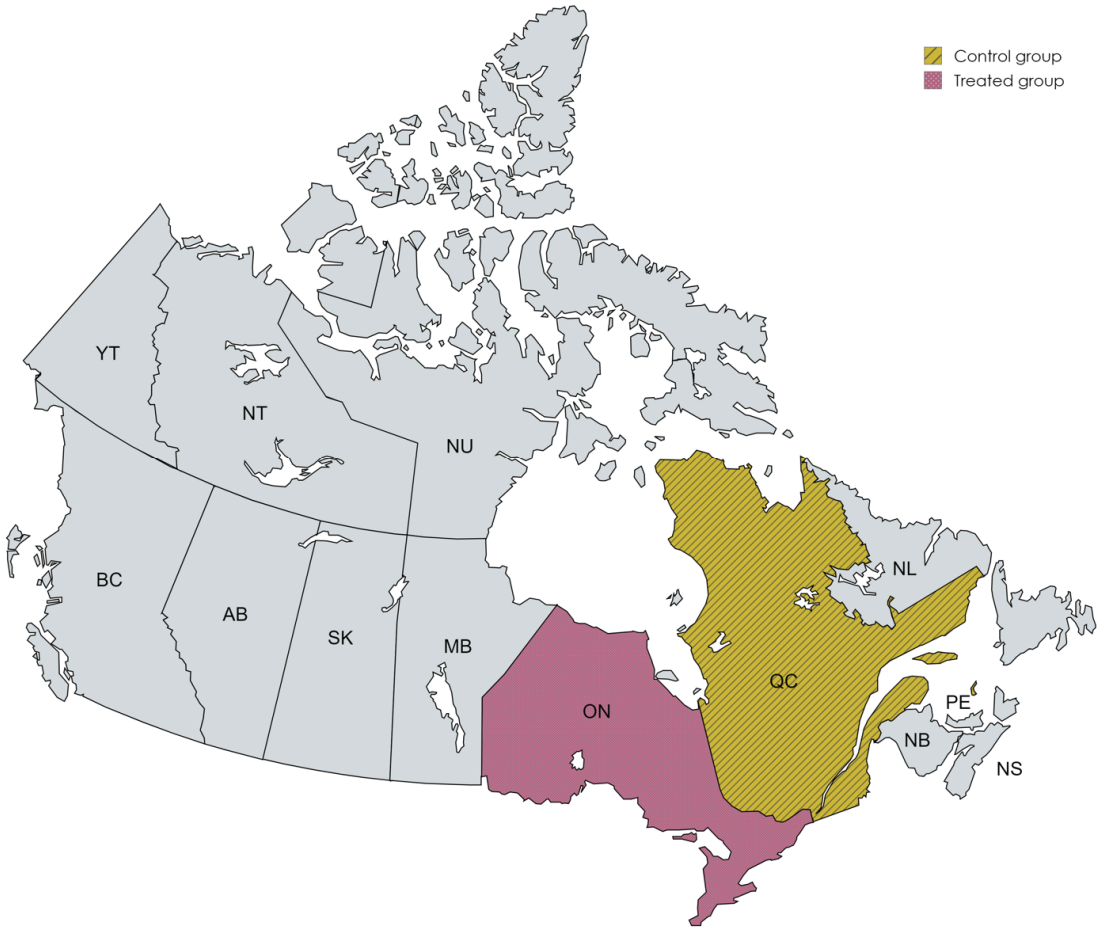
What can we say about the external validity of this study? First, personal liability for corporate environmental misconduct could be directly enforced in other jurisdictions, such as in the U.S. or other provinces in Canada. Although rarely enforced, CERCLA (one of the federal environmental legislations in the U.S.) and provincial environmental laws in Canada all include personal liability provisions for directors and executives. Personal liability for poor corporate environmental outcomes may also arise from investors, as the fiduciary duties of directors and executives evolve alongside changes in environmental regulations and social norms (Wallace, 2008, Barker et al., 2021, Ortega, 2023). Second, whether we can expect such significant social benefits in pollution reduction, as evidenced in this study, depends on the levels of corporate pollution prior to the enforcement of personal liability.

9 Conclusion

This paper investigates the benefits and costs of using personal liability for directors and executives as a mechanism to mitigate corporate environmental externalities. It leverages a landmark court case that increased perceptions of out-of-pocket personal liability risk related to corporate pollution, which affected the Province of Ontario but not the Province of Quebec in 2013. Using a difference-in-differences analysis, I show that the enforcement of out-of-pocket personal liability leads to a significant reduction in pollution, resulting in clear environmental benefits. However, the negative reaction of the stock market suggests that these benefits may come at a cost to corporations, potentially causing distortions if directors and executives excessively invest in reducing pollution.

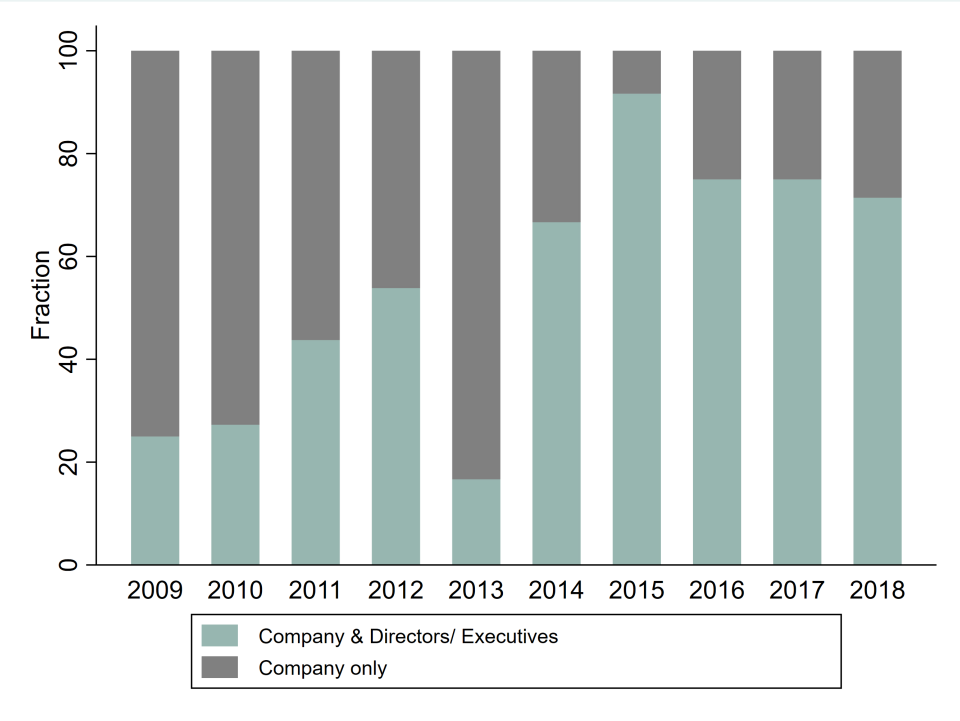
Additionally, I examine the potential consequences for the director labor market, which have historically been viewed as significant obstacles to the implementation of personal liability. Expert and wealthy directors, who are most incentivized to reduce pollution, are also more likely to leave corporate boards—a potential unintended consequence from a social planner's perspective. However, I find no evidence that independent directors are similarly inclined to exit boards. While further research is needed, this suggests that the corporate governance costs associated with personal liability may, in fact, be limited.

Figure 1: Canadian Provinces as Treated and Control Groups



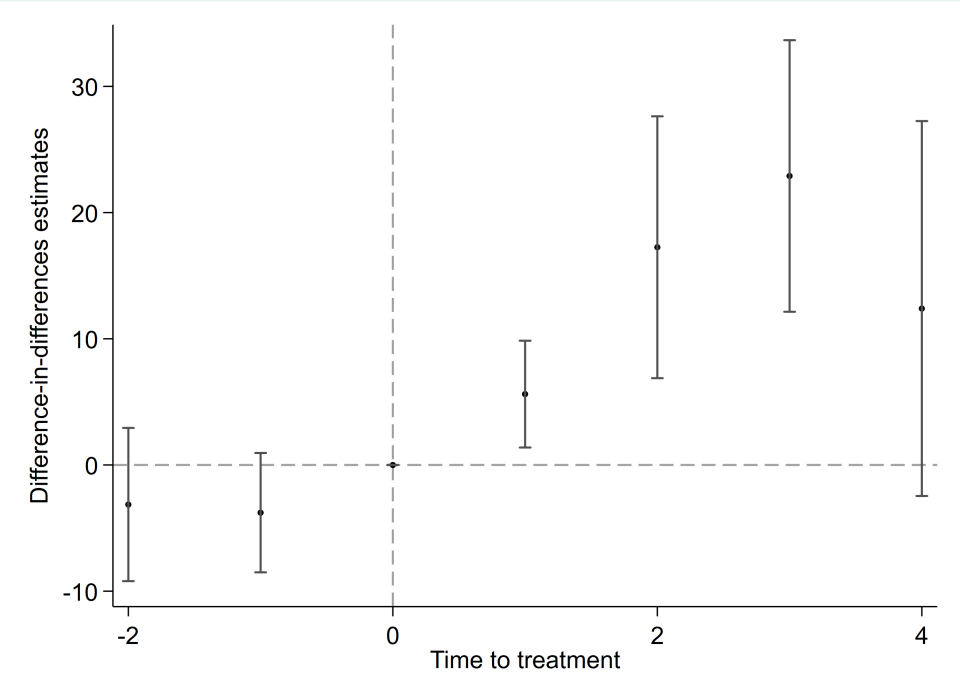
This map shows the two Canadian provinces used in the analysis as the treated (Ontario, ON) and control (Quebec, QC) groups.

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 D&O Liability Insurance Total Coverage

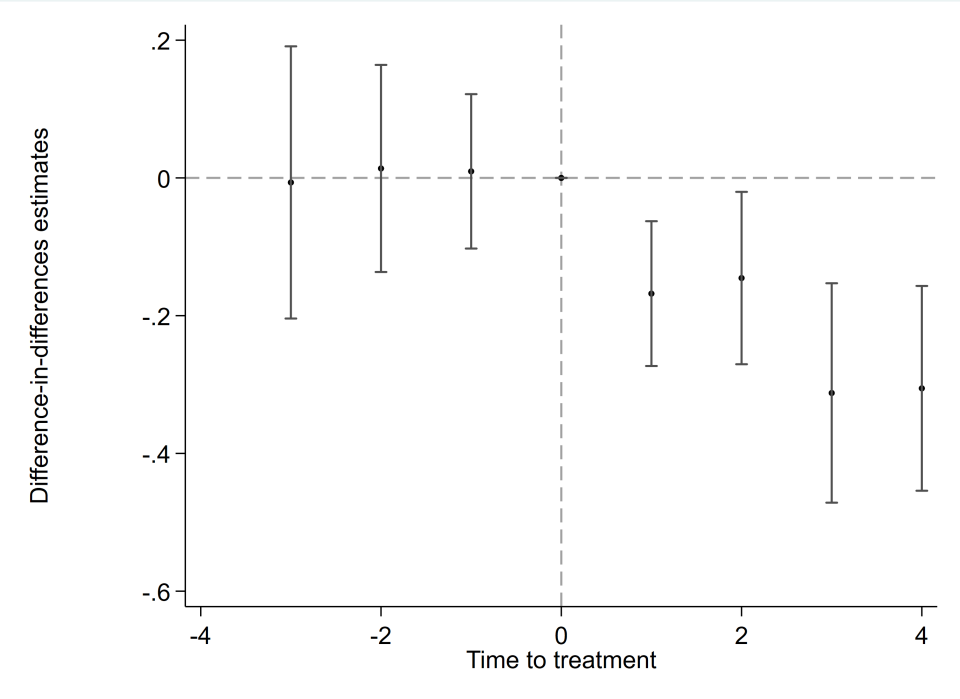


This figure reports the coefficients and confidence intervals at the 10% level of a dynamic event-study around the year of the Northstar settlement. The data is at the company-year level between 2011 and 2017 (included) and the reference year where t=0 corresponds to 2013, the year of the settlement. The treated group is the set of companies whose headquarters are located in Ontario while the control group is the set of companies whose headquarters are in Quebec. Reported coefficients, β_k, are estimated testing the specification

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

where α_c are company fixed effects and α_t are year fixed effects. The dependent variable is winsorized yearly at the 95% level and is expressed in million of Canadian dollar. Standard errors are clustered at the industry (NAICS 6-digit) level.

Figure 4: Dynamics Treatment Effects on Facility-Pollutant-level Pollution

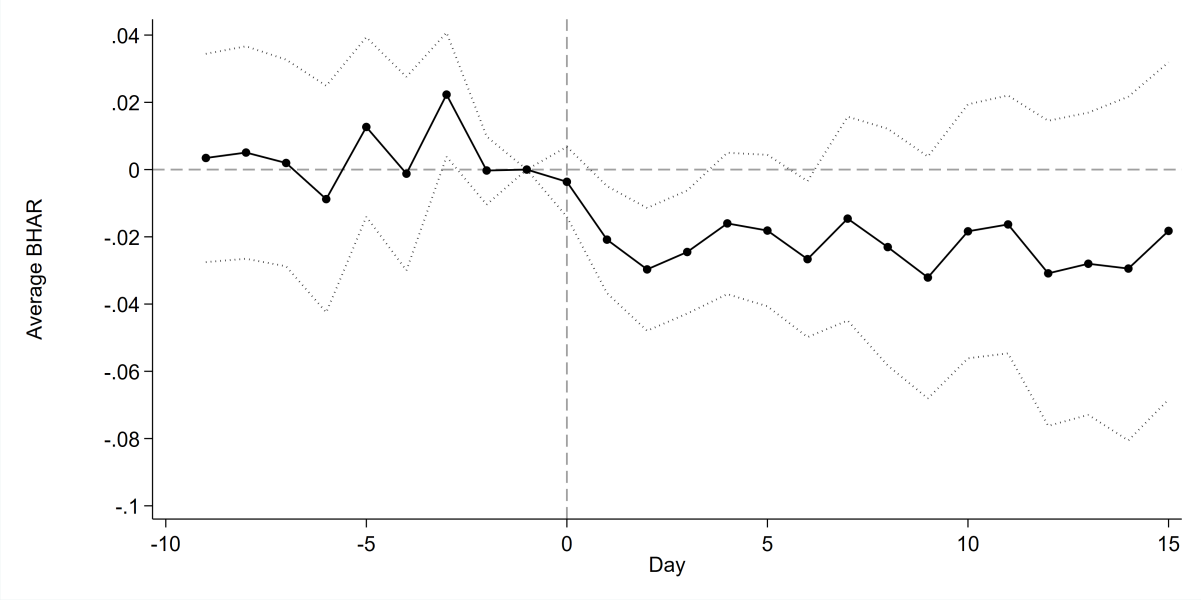


This figure reports the coefficients and confidence intervals at the 10% level of a dynamic event-study around the year of the Northstar settlement. The data is at the facility-pollutant-year level between 2010 and 2017 (included) and the reference year where t=0 corresponds to 2013, the year of the 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

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

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 5: Average Buy-and-Hold Abnormal Returns around the Northstar settlement announcement in Ontario

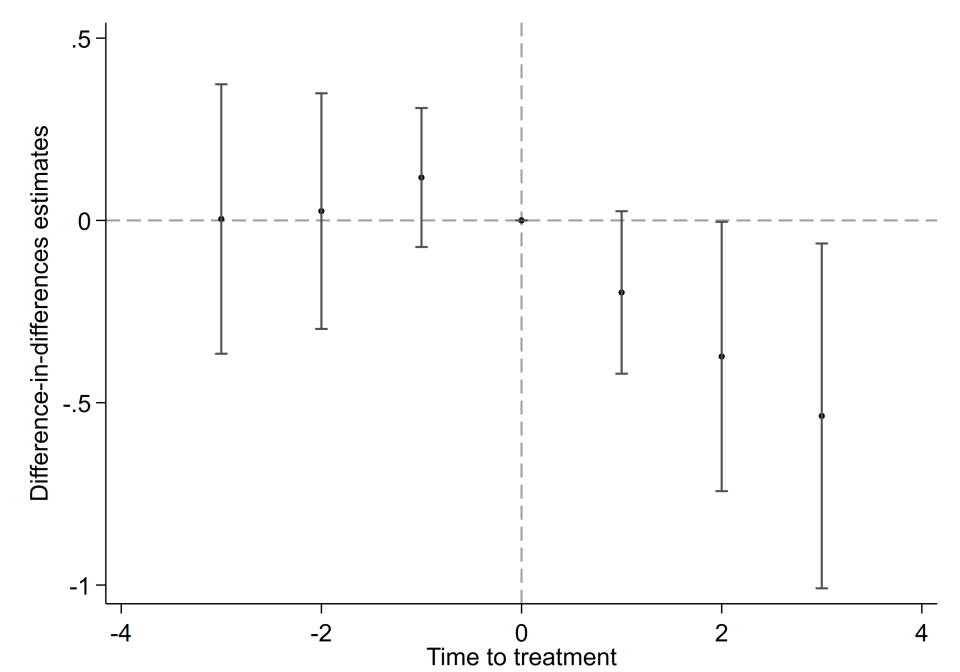


This figure reports the daily average buy-and-hold abnormal returns (BHAR) for companies that are listed on the Toronto Stock Exchange or the Toronto Stock Exchange Venture. Firms that are considered here have their headquarters in Ontario and belong to the same manufacturing sector as Northstar Aerospace 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 vertical line is the day of the Northstar settlement (October 28, 2013).

Figure 6: 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

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

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.

Table 1: Summary Statistics

Panel A: Years 2011-2016

	Observations	Mean	p10	Median	p90	SD
Facility-pollutant-year Panel						
Pollution (kgs)	31,817	32,862	0.1	83	18,626	693,466
Log(Pollution (kgs))	29,776	4.73	-0.35	4.79	9.92	4.05
Facility-year Panel						
Hours of Operation	5,053	6,406	2,080	7,462	8,736	2,599
Number of Employees	8,241	234	10	80	473	630
Company-year Panel						
Number of Employees	2,870	452	16	105	719	2,534
D&O Insurance Coverage (million)	454	90	20	55	220	91
D&O Insurance Premium (million)	453	0.47	0.01	0.19	1.51	0.62
# Directors (Insurance Data)	454	9.55	6	9	14	2.80
# Directors (BoardEx-NPRI)	454	4.39	1	3	10	3.92
# Experts (BoardEx-NPRI)	454	0.99	0	0	4	1.82
# Independent (BoardEx-NPRI)	454	2.57	0	0	8	3.52
# Wealthy (BoardEx-NPRI)	454	2.04	0	1	6	2.34

Panel B: Year before the Settlement (2012)

	Observations	Mean	p10	Median	p90	SD
Facility-pollutant-year Panel						
Pollution (kgs)	5,327	32,037	0.1	83	18,908	639,081
Log(Pollution (kgs))	4,971	4.76	-0.22	4.81	9.94	4.03
Facility-year Panel						
Hours of Operation	992	6,319	2,080	6,994	8,736	2,636
Number of Employees	1,390	218	11	80	451	503
Company-year Panel						
Number of Employees	950	433	16	103	698	2,279
D&O Insurance Coverage (million)	80	78	20	50	202	79
D&O Insurance Premium (million)	80	0.44	0.03	0.20	1.34	0.57
# Directors (Insurance Data)	80	9.6	6	9	14	2.90
# Directors (BoardEx-NPRI)	79	4.39	1	3	10	3.83
# Experts (BoardEx-NPRI)	79	1.08	0	0	5	2.04
# Independent (BoardEx-NPRI)	79	2.50	0	0	8	3.45
# Wealthy (BoardEx-NPRI)	454	2.08	0	1	6	2.29

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 before the settlement, 2012 (Panel B).

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

	Total Coverage		**Coverage/#Directors**	
	(1)	(2)	(3)	(4)
Post x Ontario	15.79***	9.87*	1.96***	1.11*
	(5.03)	(5.46)	(0.70)	(0.66)
Fixed Effects				
Company	Yes	Yes	Yes	Yes
Year	Yes	-	Yes	-
Year-Industry	-	Yes	-	Yes
Observations	442	402	442	402
R-squared	0.95	0.97	0.88	0.91
Mean Sample	88.16	88.16	8.73	8.73

Unit: million of dollars

This table reports the effects of Northstar on the company-level D&O liability total coverage (columns (1)-(2)) and the ratio of the company-level coverage to the number of directors (column (3)-(4)). 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 95% level per year. *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) level and reported in parentheses. The symbols *,**,*** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

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

	Log(Pollution)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post x Ontario	-0.180**	-0.212***	-0.210***	-0.109*	-0.292**	-0.249**	-0.286***	-0.241**
	(0.078)	(0.075)	(0.070)	(0.055)	(0.112)	(0.104)	(0.102)	(0.094)
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: Baseline Results for Most Common and Harmful Pollutants

	Log(Pollution)					
Sample	All Pollutants		21 Most Reported Pollutants		Environmental Orders Pollutants	
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Ontario	-0.210***	-0.109*	-0.203***	-0.135***	-0.212**	-0.152**
	(0.070)	(0.055)	(0.047)	(0.038)	(0.088)	(0.070)
Fixed Effects						
Facility	Yes	-	Yes	-	Yes	-
Facility-Pollutant	-	Yes	-	Yes	-	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	Yes	Yes	Yes	Yes	Yes	Yes
Observations	29,904	28,854	20,242	19,725	5,520	5,401
R-squared	0.74	0.95	0.77	0.95	0.81	0.93

This table reports the effects of Northstar on pollution releases of all pollutants (columns (1)-(2)), the 21 most reported pollutants which are listed in Table A3 (columns (3)-(4)), the pollutants that are mentioned in environmental orders by the Ontario Ministry of Environment (columns (5)-(6)). 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 5: Margins of Response

Panel Level	**1(Pollution)** Facility-Pollutant-Year			**Log(Hours)** Facility-Year			**Log(Pollution/Hours)** Facility-Pollutant-Year		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post x Ontario	-0.00	0.01	0.01	-0.02	-0.01	-0.01	-0.18***	-0.15**	-0.12*
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.05)	(0.07)	(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 6: Heterogeneity by Firms' Size

	Log(Pollution)			**Log(Hours)**			**Log(Pollution/Hours)**		
Sample	All	Small	Large	All	Small	Large	All	Small	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post x Ontario	-0.106	-0.103	-0.240**	-0.033*	-0.041*	-0.022	-0.141	-0.092	-0.213***
	(0.145)	(0.125)	(0.115)	(0.019)	(0.024)	(0.017)	(0.118)	(0.182)	(0.072)
Post x Ontario x High Employment 2012	-0.135			0.007			-0.026		
	(0.182)			(0.023)			(0.106)		
Fixed Effects									
Facility	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	-	-	-	Yes	Yes	Yes	-	-	-
Year-Pollutant	Yes	Yes	Yes	-	-	-	Yes	Yes	Yes
Year-Industry	Yes	Yes	Yes	-	-	-	Yes	Yes	Yes
Observations	27,672	8,016	19,474	4,410	1,524	2,882	18,945	4,804	13,972
R-squared	0.74	0.79	0.74	0.93	0.95	0.89	0.72	0.79	0.72

This table reports the effects of Northstar on pollution releases by company size measured by the number of employees. It reports the OLS coefficients estimated following the specification 2 for small (odd columns) and large (even columns). 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. *Small* (*Large*) is defined by the 2012 company's number of employees being below (above) the 2012 median company-level employee count in the sample. *Distressed* (*Healthy*) is defined by the 2012 company's Altman Z-score being strictly smaller than 1.81 (larger than 2.99). Standard errors are clustered at the industry (facility NAICS 6-digit) level and reported in parentheses. The symbols *,**,*** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table 7: Heterogeneity by Boards' Characteristics

	Log(Pollution)				
	(1)	(2)	(3)	(4)	(5)
Post x Ontario	0.177	0.099	0.089	0.185	0.168
	(0.237)	(0.208)	(0.249)	(0.207)	(0.197)
Post x Ontario x Ratio Wealthy 2012	-0.286***			-0.305***	-0.334**
	(0.102)			(0.102)	(0.135)
Post x Ontario x Ratio Experts 2012		-0.110		-0.096	-0.191
		(0.220)		(0.253)	(0.246)
Post x Ontario x Ratio Independent 2012			-0.068	0.006	0.169
			(0.152)	(0.154)	(0.182)
Post x Ontario x Ratio Ivy School 2012					-0.163
					(0.113)
Post x Ontario x Ratio Postgraduate 2012					-0.190
					(0.201)
Fixed Effects					
Facility	Yes	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes
Year-Industry	Yes	Yes	Yes	Yes	Yes
Observations	4,652	4,652	4,652	4,652	4,652
R-squared	0.74	0.74	0.74	0.74	0.75

This table reports the effects of Northstar on pollution releases by company-level (standardized) 2012 ratio of wealthy directors, directors who were part of an environmental committee in or before 2013, independent directors, directors who attended an Ivy League school, or obtained a post-graduate degree to the total number of directors. It reports the OLS coefficients estimated following the specification 3 where only the interactions of interest are reported. 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 (facility NAICS-6 digit) level and reported in parentheses. The symbols *,**,*** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table 8: Effects of the Northstar Settlement Announcement on Abnormal Returns in Ontario

	$BHAR_{[0,2]}$		$BHAR_{[0,5]}$		$BHAR_{[0,10]}$	
	(1)	(2)	(3)	(4)	(5)	(6)
Northstar	-0.020*	-0.021**	-0.025*	-0.026*	-0.023	-0.024
	(0.011)	(0.011)	(0.014)	(0.014)	(0.023)	(0.023)
Constant	-0.005	-0.007	0.007	0.005	0.006	0.004
	(0.006)	(0.005)	(0.007)	(0.007)	(0.013)	(0.012)
Control						
$BHAR_{[-15,-1]}$	-	Yes	-	Yes	-	Yes
Observations	828	828	828	828	824	824
R-squared	0.00	0.03	0.00	0.03	0.00	0.02

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 2 days (columns (1)-(2)), 5 days (columns (3)-(5)), 10 days (columns (5)-(6)) that follow the Northstar settlement (October 28th, 2013) as

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

where $k \in \{2, 5, 10\}$. *Northstar* 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

$$\text{BHAR[0,k]}_c = \beta \mathbf{1}_{[\text{Northstar}]c} + \delta \text{BHAR[-15,-1]}_c + \epsilon_c$$

where BHAR[-15,-1] are buy-and-hold abnormal returns over the 15 days before the announcement of the Northstar settlement. Robust standard errors are reported in parentheses. The symbols *,**,*** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table 9: Effects of Northstar on Company-level Turnover of Independent and Wealthy Directors

	Exit Fraction					
	All Directors		**Independent Directors**		**Wealthy Directors**	
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Ontario	0.09**	0.07**	0.03	0.03	0.04*	0.05**
	(0.04)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Fixed Effects						
Company	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	-	Yes	-	Yes	-
Year-Industry	-	Yes	-	Yes	-	Yes
Observations	534	534	294	294	414	414
R-squared	0.34	0.37	0.35	0.42	0.36	0.42
Mean Sample	0.08	0.08	0.06	0.06	0.04	0.04

This table reports the effects of Northstar on the ratio of the number of directors who leave the board to the total number of directors (columns (1)-(2)), the ratio of the number of independent directors who leave the board to the total number of directors conditional on having at least one independent director on the board (columns (3)-(4)), and the ratio of the number of wealthy directors who leave the board to the total number of directors conditional on having at least one wealthy director on the board (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 10: Effects of Northstar on Company-level Turnover of Environmental Expert Directors

	#Directors		#Experts		Fraction Experts	
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Ontario	-0.40	-0.48	-0.23*	-0.39***	-0.02**	-0.04***
	(0.26)	(0.30)	(0.14)	(0.13)	(0.01)	(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
Sample Mean	4.9	4.9	1.2	1.2	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)). The number of directors and the number of expert directors are winsorized at the 1% level on the right end of the distribution. 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.

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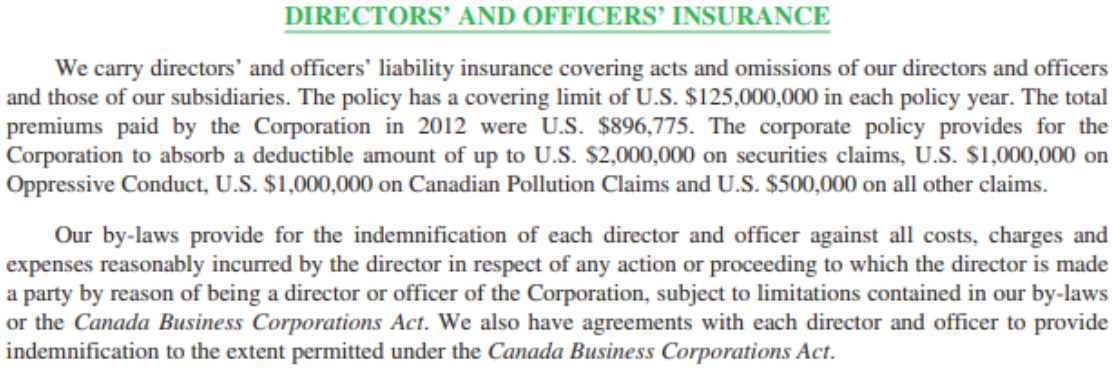
A Appendix

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

(a) Agrium Inc (2012)

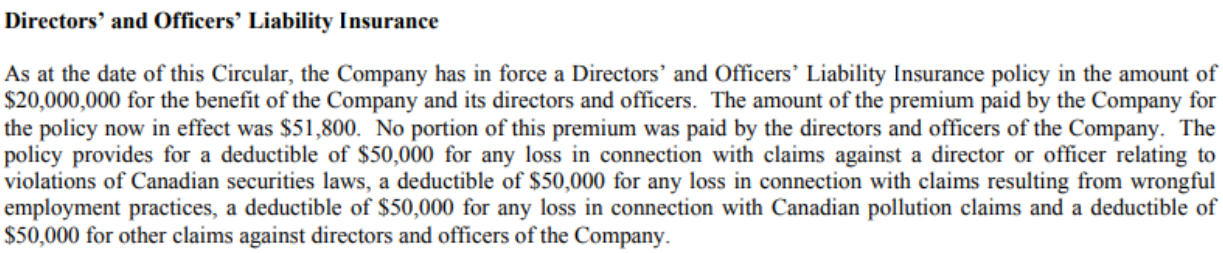


DIRECTORS' AND OFFICERS' INSURANCE

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*.

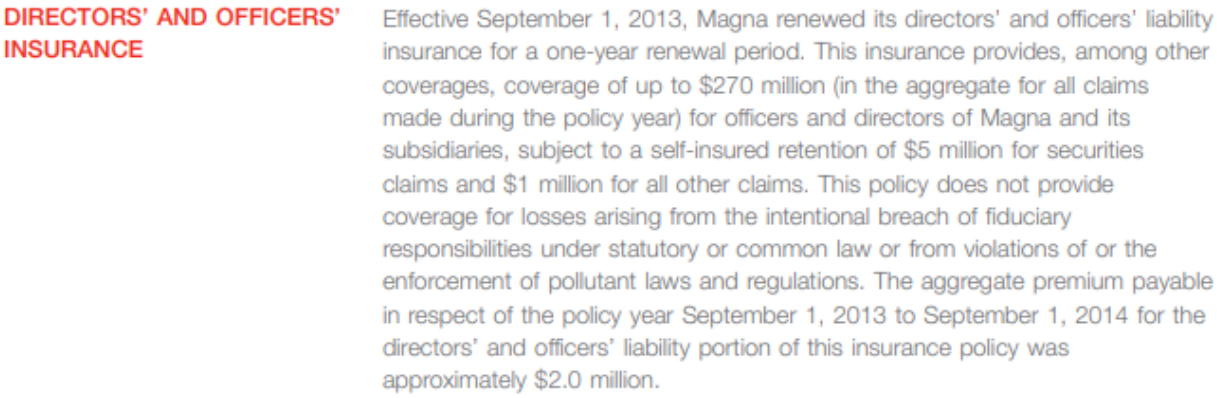
(b) Wesdome Gold Mines



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)

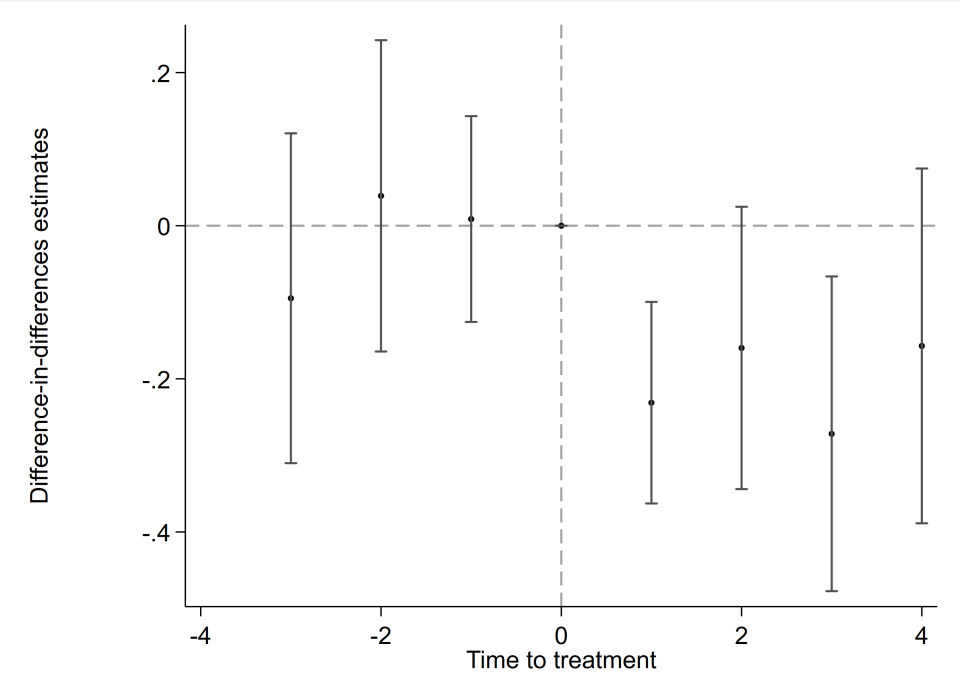


DIRECTORS' AND OFFICERS' INSURANCE

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 Within-Firm Pollution

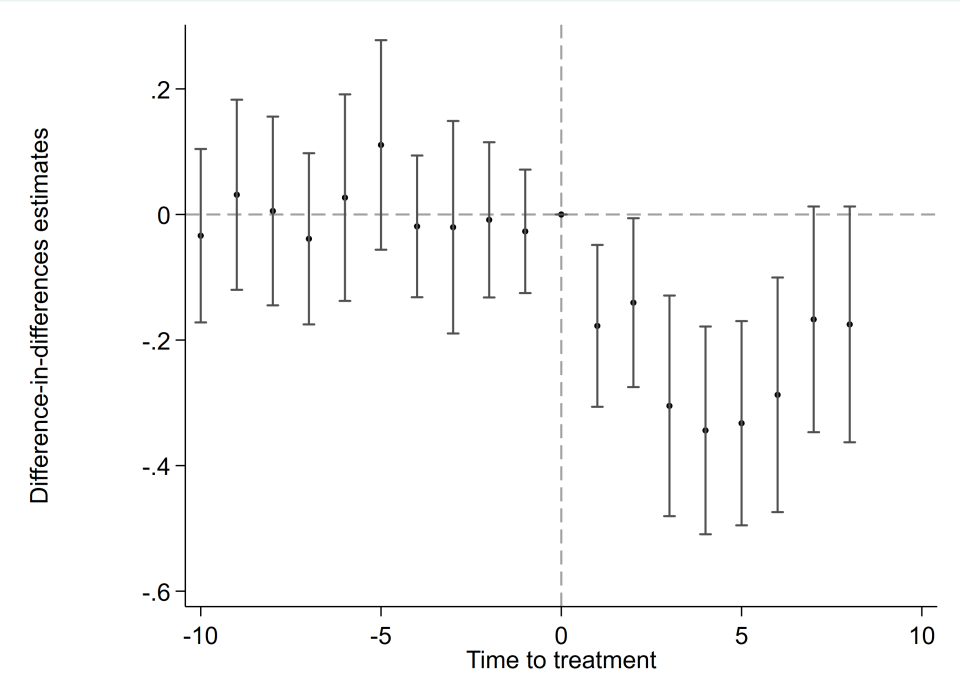


This figure reports the coefficients and confidence intervals at the 10% level of a dynamic event-study around the year of the Northstar settlement. The data is at the facility-pollutant-year level between 2010 and 2017 (included) and the reference year where t=0 corresponds to 2013, the year of the 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

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

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 A3: Dynamics Treatment Effects on Long-Term Pollution

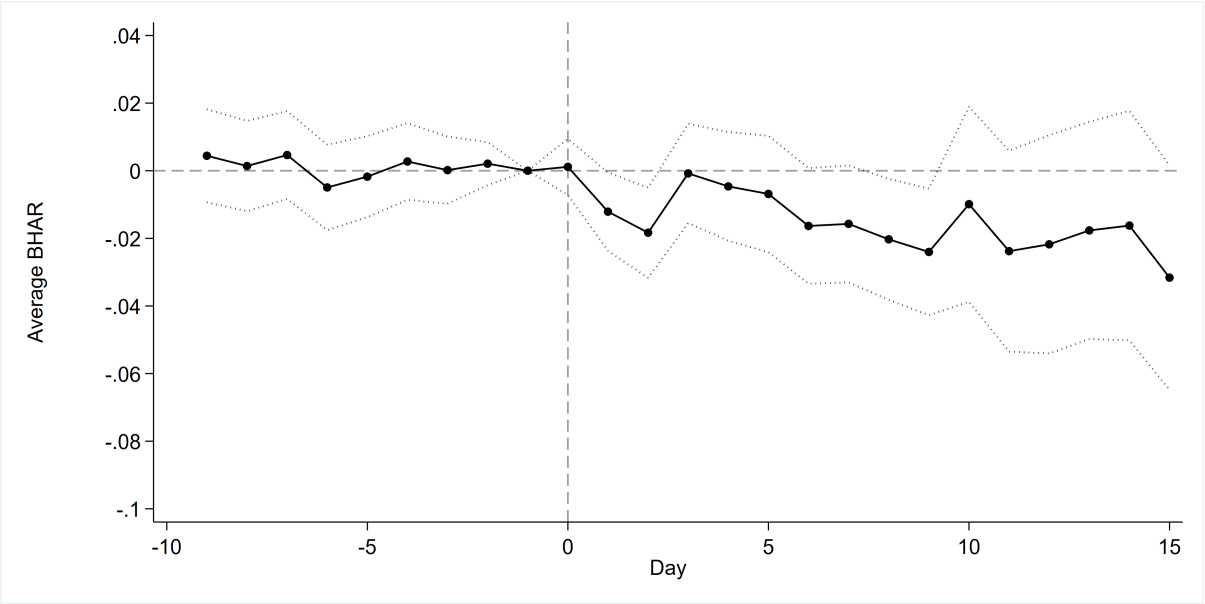


This figure reports the coefficients and confidence intervals at the 10% level of a dynamic event-study around the year of the Northstar settlement. The data is at the facility-pollutant-year level between 2003 and 2022 (included) and the reference year where t=0 corresponds to 2013, the year of the 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

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

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 A4: Average Abnormal Returns in Ontario around Northstar



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 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 and/or Executives Named in Environmental Orders in Ontario

	Individual Named
Post	0.37***
	(0.12)
Post x 1(Financial Distress)	0.31*
	(0.16)
Observations	84
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 and executive. Standard errors are robust. 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: Summary Statistics for the NPRI-BoardEx Dataset

Year before the Settlement (2012)

Sample	Low Employment				High Employment			
	Obs	Mean	Median	SD	Obs	Mean	Median	SD
# Directors	341	2.89	1	3.42	5,007	5.70	6	3.80
Ratio Experts	62	0.07	0	0.20	891	0.29	0.09	0.35
Ratio Wealthy	62	0.11	0	0.18	891	0.42	0.5	0.29
Ratio Top School	62	0.05	0	0.17	891	0.09	0	0.17
Ratio Postgrad	62	0.05	0	0.12	891	0.22	0.17	0.29
Ratio PhD	65	0.21	0	0.32	794	0.22	0.29	0.19
Ratio MBA	62	0.11	0	0.26	891	0.28	0.33	0.26
Ratio Independent	62	0.17	0	0.29	891	0.49	0.58	0.38
Number of Pollutants	1,584	5.35	4	4.41	3,743	10.27	8	9.07
Average of Pollution	1,361	29.36	0.88	102.34	3,043	63.55	4.09	512.12

This table presents the summary statistics for the board composition data from the merged datasets NPRI and BoardEx for the year before the Northstar settlement, 2012. Companies that belong to the Low Employment category have a company-level number of employees in 2012 that is below the median of the NPRI sample. Companies that belong to the High Employment category have a company-level number of employees in 2012 that is above the median of the NPRI sample.

Table A5: Description of Variables

Variable Name	Definition	Source
Post	An indicator equals to one for full calendar years after the Northstar settlement (2014-2016)	
Ontario	An indicator equals to one for facilities located in Ontario (facility-pollutant-level specifications), or that equals one for companies whose headquarters are in Ontario, or that equals to one for companies that own at least one facility in Ontario (company-level specifications)	NPRI/SEDAR
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
1(Ratio Wealthy 2012)	A firm-level continuous variable equals to the 2012 ratio of wealthy directors to the total number of directors	BoardEx, Wealth-X
1(Ratio Top School 2012)	A firm-level continuous variable equals to the 2012 ratio of directors who graduated from an Ivy League school (Harvard University, Princeton University, Yale University, Columbia University, University of Pennsylvania, Cornell University, Brown University, Dartmouth College) to the total number of directors	BoardEx
1(Ratio Postgraduate 2012)	A firm-level continuous variable equals to the 2012 ratio of directors who obtained a postgraduate degree (e.g., executive program, professional certificates) to the total number of directors	BoardEx

Variable Name	Definition	Source
Small	A firm-level indicator equals to one if the company-level number of employees in 2012 is below the median of the sample. It takes into account the number of employees in all facilities of the company that report to NPRI	NPRI
Large	A firm-level indicator equals to one if the company-level number of employees in 2012 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
Distressed	A firm-level indicator equals to one if the Altman Z-score of the company in 2012 is strictly smaller than 1.81	Compustat
Healthy	A firm-level indicator equals to one if the Altman Z-score of the company in 2012 is strictly greater than 2.99	Compustat
Northstar	A firm-level indicator equals to one if the company belongs to NAICS 33	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
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
BHAR[0,5]	Buy-and-Hold Abnormal Returns over five business days at the company level	Compustat
#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

Table A6: 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**	-0.29**	-0.21**	-0.29*	-0.21**	-0.29**	-0.21***	-0.29***
	(0.09)	(0.14)	(0.09)	(0.15)	(0.09)	(0.12)	(0.05)	(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 A7: 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 A8: Robustness: Baseline Results Estimated with Alternative Outcome Variables or Regression Models

Model	**Percentile rank within pollutant** OLS				**Log(Pollution+1)** OLS				**Pollution** Poisson			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Post x Ontario	-1.433*	-1.544**	-2.325**	-2.453**	-0.22**	-0.22***	-0.19	-0.19	-0.37***	-0.39***	-0.11	-0.10
	(0.794)	(0.731)	(1.151)	(1.007)	(0.09)	(0.08)	(0.15)	(0.15)	(0.13)	(0.14)	(0.09)	(0.10)
Fixed Effects												
Facility	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes
Year-Company	-	-	Yes	Yes	-	-	Yes	Yes	-	-	Yes	Yes
Observations	31,493	31,493	29,928	29,928	31,493	31,493	29,928	29,928	31,344	31,344	29,739	29,739
R-squared	0.63	0.63	0.65	0.66	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 where the outcome variable is the percentile rank of a given facility in Canada at the pollutant-year level (columns (1)-(4)), the natural logarithm of the pollution in grams plus one (columns (5)-(8)), the pollution in grams (columns (9)-(12)). The table reports the coefficients estimated from running the OLS regression presented in Equation (2) where the dependent variable is at the facility-pollutant-year level in columns (1)-(8). The table reports the coefficients estimated from a Poisson model where the dependent variable is the releases at the facility-pollutant-year level in columns (9)-(12). *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: Baseline Results for Firms with No Opportunity to Reallocate

	Log(Pollution)			
Sample	No Presence in Ontario And Quebec		Presence in Ontario Or Quebec Only	
	(1)	(2)	(3)	(4)
Post x Ontario	-0.168**	-0.130**	-0.166**	-0.111*
	(0.072)	(0.061)	(0.080)	(0.061)
Fixed Effects				
Facility	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes
Year-Industry	-	Yes	-	Yes
Observations	21,240	21,240	18,439	18,439
R-squared	0.76	0.76	0.76	0.76

This table reports the effects of Northstar on pollution releases for firms that have no facility in both Ontario and Quebec (columns (1)-(2)) and for firms that have all their facilities in Ontario or in Quebec (columns (3)-(4)) over the sample period, 2011-2016. 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 A10: Heterogeneity by Firms' Z-Score

	Log(Pollution)		**Log(Hours)**		**Log(Pollution/Hours)**	
Sample	Distressed	Healthy	Distressed	Healthy	Distressed	Healthy
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Ontario	0.19	-0.44**	0.00	0.03	-0.04	-0.31*
	(0.18)	(0.21)	(0.03)	(0.02)	(0.14)	(0.16)
Fixed Effects						
Facility	Yes	Yes	Yes	Yes	Yes	Yes
Year	-	-	Yes	Yes	-	-
Year-Pollutant	Yes	Yes	-	-	Yes	Yes
Year-Industry	Yes	Yes	-	-	Yes	Yes
Observations	4,493	1,994	531	325	3,271	1,518
R-squared	0.72	0.78	0.93	0.97	0.72	0.75

This table reports the effects of Northstar on pollution releases by Altman Z-score. It reports the OLS coefficients estimated following the specification 2 for financially distressed firms (odd columns) and large financially healthy firms (even columns). 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. *Small* (*Large*) is defined by the 2012 company's number of employees being below (above) the 2012 median company-level employee count in the sample. *Distressed* (*Healthy*) is defined by the 2012 company's Altman Z-score being strictly smaller than 1.81 (larger than 2.99). Standard errors are clustered at the industry (facility NAICS 6-digit) level and reported in parentheses. The symbols *,**,*** indicate statistical significance at the 10%, 5%, 1% levels, respectively.

Table A11: Baseline Results by Facility-level Pollution in 2012

	Log(Pollution)					
Sample	All Firms	Low	High	All Firms	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Ontario	-0.12	-0.14	-0.23***	-0.27	-0.28	-0.23***
	(0.11)	(0.11)	(0.08)	(0.23)	(0.22)	(0.04)
Post x Ontario x 1(# Pollutants 2012)	-0.10					
	(0.14)					
Post x Ontario x 1(Average Pollution 2012)				0.06		
				(0.23)		
Fixed Effects						
Facility	Yes	Yes	Yes	Yes	Yes	Yes
Year-Pollutant	Yes	Yes	Yes	Yes	Yes	Yes
Year-Industry	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,237	5,199	22,877	27,525	10,576	16,741
R-squared	0.74	0.86	0.72	0.74	0.67	0.62

This table reports the effects of Northstar on pollution releases by facility-level pollution measured by the number of pollutants released by the facility in 2012 (Panel A) and by the average pollution in 2012 at the facility-level (Panel B). It reports the OLS coefficients estimated following the specification 2 for low level of pollution (columns (2) and (5)) and high level of pollution (columns (3) and (6)). 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. *1(# Pollutants 2012)* is a dummy that equals one if the facility's number of pollutants in 2012 was higher than the median facility-level pollutant count in the sample. *1(Average Pollution 2012)* is a dummy that equals one if the average level of pollution for pollutants measured in tons is higher than the median facility-level average pollution. 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 A12: Robustness: Effects of Northstar on Alternative Measure of Company-level Turnover of Directors

	All Directors		**Independent Directors**		**Wealthy Directors**	
	(1)	(2)	(3)	(4)	(5)	(6)
Post x Ontario	0.09**	0.07**	0.04	0.04	0.08*	0.10**
	(0.04)	(0.03)	(0.05)	(0.06)	(0.04)	(0.04)
Fixed Effects						
Company	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	-	Yes	-	Yes	-
Year-Industry	-	Yes	-	Yes	-	Yes
Observations	534	534	294	294	414	414
R-squared	0.34	0.37	0.30	0.37	0.33	0.40
Mean Sample	0.08	0.08	0.09	0.09	0.07	0.07

This table reports the effects of Northstar on the ratio of the number of directors who leave the board to the total number of directors (columns (1)-(2)), the ratio of the number of independent directors who leave the board to the number of independent directors conditional on having at least one independent director on the board (columns (3)-(4)), and the ratio of the number of wealthy directors who leave the board to the number of wealthy directors conditional on having at least one wealthy director on the board (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 A13: Effects of Northstar on Company-level Turnover of Educated Directors

	Bachelor		**Master**		**PhD**		**MBA**		**Postgraduate**		**Top School**		**Age > 65**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Post x Ontario	0.06*	0.05	-0.00	-0.01	0.00	0.01	0.07**	0.04*	0.05**	0.04*	0.06*	0.04*	0.08**	0.04
	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.04)	(0.03)
Fixed Effects														
Company	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-
Year-Industry	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes
Observations	472	472	245	245	281	281	369	369	275	275	183	183	482	482
R-squared	0.34	0.37	0.32	0.44	0.28	0.34	0.27	0.32	0.33	0.43	0.27	0.33	0.31	0.35
Sample Mean	0.06	0.06	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.07	0.07

This table reports the effects of Northstar on the ratio of the number of directors with a Bachelor degree (columns (2)-(3)), Master's degree (columns (3)-(4)), a PhD degree (columns (5)-(6)), a MBA degree (columns (7)-(8)), a postgraduate degree (columns (9)-(10)), a degree from an Ivy League school (columns (11)-(12)), aged more than 65 years old (columns (13)-(14)) who leave the board to the number of directors conditional on having at least on director who has this characteristic on the board. 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.