

Does Private Equity Ownership Make Firms Cleaner? The Role Of Environmental Liability Risks

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Does Private Equity Ownership Make Firms Cleaner? The Role Of Environmental Liability Risks*

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Abstract

This paper shows that private equity (PE) ownership, in private-to-private buyouts, leads to a reduction in pollution when the target company faces high potential liabilities for polluting. Conversely, PE-backed firms increase pollution when environmental liability risks are low, as shown by a novel natural experiment that reduced these risks for projects located on federal land. Exploiting specific PE deals within the energy industry, I find that PE governance is the main driver of the results. The results suggest that increasing litigation and regulation-related risks can mitigate the potentially detrimental effects of PE ownership on stakeholders.

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1 Introduction

Since the pioneering work by [Becker \(1968\)](#), a large body of literature argues that individuals and firms decide whether or not to comply with the law based on a rational assessment of the associated costs and benefits. This literature assumes that ownership structures are irrelevant to understanding these choices. However, private equity (PE) firms often communicate that they "fully comply and/or exceed compliance with applicable environmental regulatory requirements."¹ On the contrary, critics of PE firms often view their high-powered incentives to maximize profit as "threats to (...) environmental protections."² One particular threat is that PE firms could reap the benefits of reduced compliance through higher dividends or fees, but avoid potential environmental fines or lawsuits by filing their portfolio company for bankruptcy. Does PE ownership affect the pollution of their portfolio companies, especially when the legal liabilities of polluting are high, compared to other forms of ownership?

Firms are exposed to low legal liabilities when rules are not perfectly enforced, when their stakeholders face friction(s) to litigation, or when the current or future degree of regulation is low. In this paper, I show that PE-backed firms reduce pollution when the potential liabilities of polluting are high. The main result of this paper is that PE-backed firms are more sensitive than other types of ownership to these costs. This result is consistent with the view that PE firms change the governance of their portfolio companies and take actions that enhance shareholder value. In particular, these actions are part of the operational engineering channel, wherein PE firms develop industry and operating expertise ([Gompers, Kaplan, and Mukharlyamov \(2016\)](#)). This operating expertise could include an in-depth understanding of the legal environment of

¹ENCAP Investments, leading oil and gas private equity firm. More citations and self-reported evidence on how private equity firms act regarding environmental externalities are available in Table 7 of the online appendix. There are also many cases in which PE-backed firms took environmentally friendly actions. For instance, the private-equity backed firm Vista Proppants & Logistics planned to build a sand mine in a place that turned out to be the natural environment of the Sagebrush lizard. Although the lizard is not in any endangered species list, the firm worked with environmentalists to ensure that the smallest possible number of lizards were harmed. ("Private Equity Works to Be Both Social Steward and Profit Engine" by Melissa Mittelman in Bloomberg, 2018.).

²Elizabeth Warren, Mark Pocan, Raúl M. Grijalva, Deb Haaland, Rashida Tlaib, Jesús G. "Chu" García, and Sheldon Whitehouse (December 16, 2019).

the PE's portfolio companies.³ They may be more attuned to legal risks than other closely-held private firms and react more strongly to incentives put in place by governments. This result implies that PE-backed firms are more sensitive to the legal liability created by governments' enforcement and regulation activities.

I provide evidence for this mechanism by studying the toxic pollution released by firms in the US oil and gas industry. Focusing on this empirical setting offers several advantages. First, I use novel high-frequency project-level data on corporate environmental policies and novel PE ownership data. Specifically, I merge administrative data on chemicals used in the production process for 166,279 US wells fracked from 2012 through 2021 with granular information on the characteristics of each well. I exploit the granularity of the data by controlling for different time trends at the hyper-local area level. These controls absorb salient differences among projects from PE-backed and non-PE-backed firms. Using geographic variables to control for unobserved differences in technology or productivity between projects is a common approach in the literature that uses the fracking industry as an empirical setting (Gilje and Taillard (2016); Gilje, Loutskina, and Murphy (2020)).

Second, I exploit the fracking legal framework to determine whether the well faces high environmental liability risk. Employing toxic chemicals is legal for fracking firms and is subject to lower permit requirements than in other industries. While legal, a firm's reliance on toxic chemicals during fracking increases its environmental liability risk on several dimensions. Using more toxic chemicals increases the probability of environmental legal liability because any contamination caused by these chemicals exposes the responsible party to tort and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) liabilities.⁴

³Consistent with the idea of higher sensitivity of PE firms to legal liability, the author writes: "If Vista and First Reserve had come heavy, they'd doubtlessly have had to deal with lawsuits, habitat mitigation, and media reports portraying them as villains. By engaging with conservationists, Vista mitigated risk. And by mitigating risk, Vista was making a smart business decision." ("Private Equity Works to Be Both Social Steward and Profit Engine" by Melissa Mittelman in Bloomberg, 2018.).

⁴For instance, in 2012, EPA issued an Action Memorandum for the Dimock drilling site to "request and document approval of an emergency removal action to prevent, limit, or mitigate the threats posed by the presence of hazardous substances (...) pursuant to Section 104(a) of the Comprehensive Environmental Response, Compensation and Liability Act."

In addition, the controversy surrounding the exemption of these chemicals from federal statutes makes them subject to potential future regulation, thereby adding another dimension of risk associated with their use. Finally, fracking activities expose the operator to legal lawsuits because these chemicals have high media exposure and are often used by non-governmental organizations to challenge fracking activities. Supporting the consistency of the measure, I replicate several known facts with respect to corporate pollution.

Third, I exploit the geographic heterogeneity in environmental liabilities to which oil and gas firms are exposed so as to evaluate the influence of these liabilities on PE-backed firms. Firms in the oil and gas industry are subject to different environmental liability risks, which vary over time and space. One notable advantage of having within-firm variations in environmental liability risks is that it allows for the inclusion of a firm-year fixed effect. This fixed effect mitigates the influence of omitted variables that could affect both the decision of a PE firm to acquire a company and the decision of this acquired company to pollute. This firm-year fixed effect also ensures that the change in pollution is not an unintended effect of adopting new technology or other firm-level operational changes.

I start the analysis by showing that pollution drops following the PE buyout. This result contradicts the risk-shifting view, wherein PE-backed firms take excessive environmental risks following their acquisition. This pollution reduction is consistent with the view that PE-backed firms are more sensitive to government incentives. However, this effect could be driven by many other economic mechanisms, such as a reduction in budget constraints or an increase in productivity with unintended consequences on pollution.⁵ I exploit cross-sectional variation in environmental liability risk and study the differential response by PE-backed firms so as to provide additional evidence that those firms react to greater environmental regulation risk by decreasing their pollution levels.

⁵In particular, [Xu and Kim \(2022\)](#), find that financial constraints lead to an increase in pollution. [Boucly, Sraer, and Thesmar \(2011\)](#) show that PE buyouts lead to lower financial constraints. [Shapiro \(2022\)](#) finds that more productive firms pollute less. [Davis et al. \(2014\)](#) show that PE ownership leads to additional productivity gains.

Specifically, I document that PE-backed firms reduce their relative usage of toxic chemicals for projects in states with high liability risks. I use the Lawsuit Climate Survey, which reports the perceptions of US businesses of how fair and reasonable states' liability systems are. This survey captures the subjective ex-ante expectation of corporate actors regarding legal risks, giving it an advantage with respect to measuring those risks. I find that PE ownership leads to a relative reduction in the pollution of new projects by 68.79% of the baseline pollution level if the project is located in a state with a surveyed liability risk above the sample median. The result is shown after controlling for project-level time-varying characteristics, such as the projects' production and technology, and any firm-level or hyper-local specific unobserved heterogeneity.⁶

I do not observe any effect on pollution in places with high environmental liability risks when the PE firm provides equity financing to a company but does not control the management team. To show this result, I rely on a type of PE deal that exists only in the oil and gas industry: DrillCo contracts. To my knowledge, this paper is the first to document and exploit this class of PE contracts. In such contracts, the PE firm provides capital for projects in exchange for cash flow rights from these projects. Interestingly for my empirical design, the PE firm does not control the firm's management in a DrillCo. When replicating the specifications used for the buyout results, I show that firms do not reduce pollution in high environmental risk states when the PE sponsor cannot control its portfolio companies, as when a DrillCo agreement is in place.

Although the previous results are informative, I cannot rule out the possibility of selection bias between PE ownership, pollution, and environmental liability risk. To better validate the interpretation that PE-backed firms are more responsive to legal changes affecting the liabilities they face, I exploit plausibly exogenous changes in the environmental liability risks faced by projects located in specifically affected areas. Namely, I exploit a succession of legal and

⁶I show that the results are robust to an alternative measure of environmental liability risk. Specifically, the results hold when I use an enforcement risk measure from the political science literature (Konisky (2007)).

political shocks that blocked the ability of the Bureau of Land Management (BLM) to regulate fracking on Native American reservations and federal lands from 2016 through 2018.

The exogeneity assumption of the regulation shock to unobserved variables affecting the cost of pollution is credible. The boundaries of Native American reservations and federal lands had been decided at the end of the nineteenth and the beginning of the twentieth centuries and overlap shale basins quasi-randomly, as horizontal drilling and hydraulic fracturing were not widely used until the beginning of the twenty-first century.⁷ Using this empirical design, I show that projects from PE-backed firms in areas with lower regulation risk contained more toxic pollution than other projects from PE-backed firms in areas with no changes to regulatory risk. The relative increase in pollution following the regulation shock is quantitatively large, equivalent to an increase of 94.02% in the usage of pollution for the new projects.

To support these results, I run several robustness tests. I rule out the alternative explanation that production changes drive pollution results. I also show that the results are robust to using two different Environmental Protection Agency (EPA) classifications of toxic chemicals. Finally, I assess the robustness of the results to different specifications by reporting the coefficients from 768 different regressions and investigate the robustness of the results to deviations from the pre-trend assumptions.

More work is needed to evaluate the external validity of the result. That said, this paper's findings offer a potential explanation that could unify the a priori conflicting results found within the extant literature on the externalities of private equity ownership. PE ownership harms stakeholders in some industries (Eaton, Howell, and Yannelis (2020); Liu (2021); Ewens, Gupta, and Howell (2022); Gupta et al. (2023); Kirti and Sarin (2023); Olbert and Severin (2023)), but benefits stakeholders in others (Bernstein and Sheen (2016), Agrawal and Tambe (2016), Cohn, Nestoriak, and Wardlaw (2021); Johnston-Ross, Ma, and Puri (2021); Spaenjers and Steiner (2023)). The liabilities imposed by governments on firms, through enforcement and regula-

⁷This quasi-random overlapping of shale boundaries and BLM areas is supported by the balance in most characteristics prior to 2015 for projects around the borders of areas regulated by the BLM.

tion activities, differ significantly in degree among the various industries. For this reason, PE buyouts might have different impacts on stakeholders.

While a complete meta-analysis is outside the scope of this paper, the results suggest that the degree of liabilities a firm faces can help us understand whether PE ownership causes operational changes that benefit society.⁸ This paper implies that policy and public debates should focus less on whether PE buyouts should be allowed and more on whether the current legal system and enforcement practices protect stakeholders' interests when private equity buyouts occur.

This paper also contributes to the literature on the externalities of PE ownership by studying its impact on the people exposed to the cost of pollution.⁹ The extent to which PE firms affect the environmental practices of their target companies has come under recent attention in the public sphere. For instance, in the US, some members of Congress have expressed concern that "the private equity industry poses significant threats to international environmental protections and efforts to combat global climate change."¹⁰ However, as noted by [Sorensen and Yasuda \(2022\)](#), most academic papers focus exclusively on the operational consequences of PE ownership for consumers, workers, and governments. One exception is [Shive and Forster \(2020\)](#), who study the impact of listing status on greenhouse gas emissions. [Shive and Forster \(2020\)](#) show that PE buyouts increase air pollution for PE-backed firms. Their sample does not include the upstream oil and gas industry and is tilted toward large establishments. I show that the effect of PE buyouts on pollution is the opposite in the upstream oil and gas industry for private-to-private deals when looking at toxic releases. Toxic releases are one of the main factors affecting

⁸Doing such a meta-analysis would face important challenges. One would need a measure of legal liability that distinguishes the party involved, that is, whether the liability aims to protect workers, shareholders, consumers, or the environment. Moreover, such a measure would have to be available at a very granular industry level, and capture the changes in enforcement activity over time and space.

⁹Other factors affecting pollution decisions include other financial investors ([Akey and Appel \(2019\)](#); [Chu and Zhao \(2019\)](#); [Dyck et al. \(2019\)](#); [Naaraayanan, Sachdeva, and Sharma \(2019\)](#)), supply chains ([Schiller \(2018\)](#)), CEO preferences ([Di Giuli and Kostovetsky \(2014\)](#); [Li, Xu, and Zhu \(2021\)](#)), financial constraints ([Cohn and Deryugina \(2018\)](#), [De Haas and Popov \(2019\)](#), [Levine et al. \(2019\)](#), [Bartram, Hou, and Kim \(2022\)](#), [Xu and Kim \(2022\)](#), [Bellon et al. \(2024\)](#)).

¹⁰Elizabeth Warren, Mark Pocan, Raúl M. Grijalva, Deb Haaland, Rashida Tlaib, Jesús G. "Chu" García, and Sheldon Whitehouse (Letter to Blackstone Group, December 16, 2019).

biodiversity.¹¹ Corporations are exposed to biodiversity risks in a way that is different from climate change risks (Giglio et al. (2023)). Moreover, the upstream oil and gas industry is relevant to study in itself, given its high exposure to climate transition risks (van Benthem et al. (2022)). Finally, the results of Shive and Forster (2020) can be explained by a large set of mechanisms, such as a change in budget constraints or production scale. My paper refines the economic mechanism through which PE ownership affects firms' pollution outcomes. In particular, the results are consistent with the view that PE firms plausibly transfer operational skills to their acquired firms, which causes a higher sensitivity of PE-backed firms to potential environmental legal costs and leads to pollution changes.

This paper has implications on the potential transfer of production to private ownership caused by the pressures of environmentally conscious investors on publicly listed firms. One concern is that these pressures cause public assets to be owned by private firms (Duchin, Gao, and Xu (2022); Starks (2023)). This paper shows that if the pressures of environmentally conscious investors correlate with environmental pressures from litigation or regulations, then the firm could still reduce total pollution, because the high-powered incentives of PE firms make them more sensitive to potential legal risks. However, if investors' Environmental, Social, and Governance (ESG) pressures are a substitute for the lack of governmental actions on environmental topics, as in Bénabou and Tirole (2010), shifting public activities toward private ownership could result in more pollution.

This paper complements survey-level evidence on why financial investors engage with their portfolio companies on corporate environmental policies. Publicly-listed firms that have high ESG performance are less exposed to risks (Godfrey, Merrill, and Hansen (2009); Oikonomou, Brooks, and Pavelin (2012); Jo and Na (2012); Kim, Li, and Li (2014); Hoepner et al. (2018); Albuquerque, Koskinen, and Zhang (2019); Ilhan, Sautner, and Vilkov (2021)). Similarly,

¹¹Two recent European Union (EU) policy initiatives ("EU Biodiversity Strategy for 2030" and "EU Action Plan: Towards a Zero Pollution for Air, Water, and Soil" have explicitly recognized toxic releases as one of the "five main direct drivers of biodiversity loss," consistent with environmental scientific findings (Bernhardt, Rosi, and Gessner (2017); Rillig et al. (2019); Brack et al. (2022); Groh et al. (2022))

Krueger, Sautner, and Starks (2020) show that surveyed institutional investors cite managing environmental risks as the main reason they engage with their portfolio firms. This paper complements that literature by focusing on another class of investors: private equity firms. It shows that PE investors negatively affect environmental outcomes when environmental regulation liability risk is low, supporting a risk-based channel of environmental engagement by private financial investors.

The rest of the paper is organized as follows. Section 2 provides the institutional background of the empirical setting and section 3 describes and validates the datasets used. Section 4 details the paper's empirical strategy. Section 5 details the main result that PE ownership leads to a reduction (increase) of pollution when environmental liability risks are high (low). Section 6 performs several robustness tests. Section 7 concludes.

2 Institutional Background

This section presents the specificities of the upstream oil and gas industry that are important to understand for the empirical design. Subsection 2.1 shows how shale oil and gas operators produce pollution and why this pollution is important for regulators and firms. Subsection 2.2 describes the regulation of the fracking industry. Subsection 2.3 exposes the type and nature of PE contracts specific to the upstream oil and gas industry.

2.1 Shale oil and gas drilling and pollution

The production of natural gas in the US increased by more than 25% from 2007 to 2013, and the production of oil nearly doubled between 2009 (5.4 Mb/d million barrels of oil per day) and 2014 (9.4 Mb/d at year-end 2014), following the discovery of hydraulic fracturing and horizontal drilling.¹² Horizontal drilling allows the exploitation of reserves located in a horizontal reservoir, which could not be exploited with a traditional vertical well. Hydraulic fracturing is

¹²Oil production from fracked wells accounts for nearly half of US production (US EIA (2016)).

the practice of creating cracks in the rock so that oil and gas can circulate to the well for subsequent extraction. These cracks are made by injecting high-pressure water mixed with different chemical components, technologies that enable the exploitation of large, untapped reserves of hydrocarbons captured in porous and low-permeability rocks. The extraction of oil and gas reserves starts once the bedrock is broken up by high pressure water mixed with chemicals.

The extraction of oil and gas, especially through hydraulic fracturing, generates pollution in multiple ways. Chemicals used in the fracturing process can be highly toxic for the biosphere. For instance, various solid materials, including treated sand or ceramics (proppants) are injected to ensure that the fractures remain open and to create a high-conductivity pathway for the hydrocarbons to reach the surface easily. Antibacterial agents are included in the fracking mix to reduce bioclogging and corrosion. A clay stabilizer is added so that the clay does not swell. Other toxic chemicals can be included depending on the situation. These components can come into contact with humans and ecosystems, via groundwater contamination, flaring, or leaks from storage tanks.

Oil and gas activities also generate pollution via flaring, which consists of burning rather than recovering the gas contained in oil wells. Flaring let the firm avoid the cost of investing in infrastructure—such as that for connecting the well to a pipeline—to allow exploitation of the gas. The burnt gas can disperse toxic chemicals to the neighborhood, contaminating the air.

Toxic chemicals used by fracking firms impact the welfare of local residents. A wealth of evidence suggests that this pollution affects the health of people living close to wells, reflected in the reduced prices for houses close to fracking areas ([Muehlenbachs, Spiller, and Timmins \(2015\)](#)). To date, 18 million households that live at least one mile from a well have been exposed to these toxic pollutants ([Konkel \(2017\)](#)). This number will grow as US onshore production expands. According to the 2010 decennial census, more than 55 million households are located in a shale basin and thus risk exposure to toxic chemicals. In particular, toxic releases from fracking activities, as recognized by the Center for biological diversity, threaten plants, wildlife, and the sustainability of ecosystems. More generally, toxic chemical releases have been found to

have profound and far-reaching effects on biodiversity and ecosystem health (Bernhardt, Rosi, and Gessner (2017); Rillig et al. (2019); Brack et al. (2022); Groh et al. (2022)). As a result, two recent European Union (EU) policy initiatives ("EU Biodiversity Strategy for 2030" and "EU Action Plan: Towards a Zero Pollution for Air, Water, and Soil") have explicitly recognized toxic releases as one of the "five main direct drivers of biodiversity loss."

2.2 The regulation of pollution in the US oil and gas industry

The release of toxic components in natural surface waters —such as lakes, rivers, streams, wetlands, and coastal areas— is controlled in the US by the Clean Water Act (CWA), and the Safe Drinking Water Act (SDWA). The regulation of toxic waste and the handling of cleanup is managed by the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The release of toxic components into the air is regulated by the Clean Air Act (CAA). The industry is exempt from RCRA and CERCLA liabilities following a contamination, as long as the contamination is not caused by fracking chemicals. The practice of hydraulic fracturing has been exempt from the SDWA, and from important permitting and pollution control requirements included in the CWA since the Energy Policy Act of 2005.¹³

The highly controversial exemption is based on the idea that fracking does not affect local communities.¹⁴ I exploit these exemptions in my empirical analysis to define a variable of overcompliance. I select chemicals that the April 2011 report from the US House of Repre-

¹³This exemption does not apply to diesel fuels from hydraulic fracturing.

¹⁴In 1997, the EPA was ordered by a decision from the US Court of Appeals of the 11th Circuit to include hydraulic fracturing in the SDWA. In 2001, a special task force led by Vice President Dick Cheney asked that Congress exempt hydraulic fracturing from the SDWA. The EPA released a report in 2004 claiming that hydraulic fracturing "poses little or no threat" to drinking water. As a result, the 2005 energy bill withdrew the ability of the EPA to regulate hydraulic fracturing activities. This exemption and the EPA report preceding it were highly controversial. In March of 2005, evidence of potential mishandling in the EPA study of 2004 was officially found. Moreover, the Oil and Gas Accountability Project (OGAP) organized a review of the 2004 report and found proof that the EPA removed from its initial drafts any section suggesting that unregulated fracturing could be detrimental to human health. Subsequent research and anecdotal evidence support the view that fracking activities can be detrimental to human health and ecosystems (Bonetti, Leuz, and Michelon (2021)).

sentatives Committee on Energy and Commerce has labeled as toxic and hazardous to human health. Health scientists agree on the high degree of toxicity of these chemicals, and anecdotal stories of local contamination from these components have been reported.¹⁵ Consequently, these chemicals receive greater media exposure and have been reported by several environmental organizations as threatening human health. With one exception, these chemicals are regulated by the SDWA and CAA but are subject to the fracking industry exemption. Table 1 reports the names of all the chemicals used in the analysis, as well as their CASN numbers and whether they are regulated by SDWA and CAA. For robustness, I also exploit two different toxicity classifications, namely the EPA list of extremely hazardous substances (EHS) and the chemicals identified as harming human health in the EPA's Integrated Risk Information System (IRIS).

The extent to which this exemption applies to the Bureau of Land Management (BLM) has been the subject of an ongoing legal dispute. The Bureau of Land Management (BLM), a federal agency under the US Department of the Interior, is responsible for managing federal lands and Native American reservations, including regulating oil and gas drilling activities. In 2012, the BLM proposed a regulation to mitigate the environmental impact of hydraulic fracturing, but it faced legal challenges, including a preliminary injunction in 2015 that halted the rule's implementation. The rule was ultimately abrogated in 2016. Following the inauguration of former President Donald Trump in 2017, the BLM withdrew its support for the regulation, aligning with the new administration's policies. In response, California and environmental groups sued the BLM in 2018, arguing the rescission violated the Administrative Procedure Act by failing to explain the benefits of the policy change. As a result, it was highly likely that the BLM could not regulate fracking from 2015 through 2018. Online Appendix Highlight 2 provides additional details on the legal dispute regarding the ability of the BLM to regulate fracking.

¹⁵See for instance, EPA, Fact Sheet: January 2010 Sampling Results and Site Update, Pavillion, Wyoming Groundwater Investigation for examples of contamination due to 2-butoxyethanol.

2.3 Private equity in the oil and gas industry

Several features of the upstream oil and gas industry make it attractive for PE investment. First, this industry is a capital-intensive sector. For instance, in 2009, the median well cost exceeded \$4 million (Gilje and Taillard (2016)), and the average cost for a proposed onshore US gas pipeline was \$7.65 million per mile in 2015-2016. Second, the cyclical nature of the oil and gas industry and its vulnerability to price changes make it a risky sector. Third, difficulties in observing the quality of oil and gas reserves creates ample asymmetric information with respect to the investment opportunity set of those companies. Adverse selection is so pervasive that oil and gas firms make inefficient production decisions to prove the quality of their reserves (Gilje, Loutskina, and Murphy (2020)). The presence of risk and asymmetric information, which deter classical bank lending, coupled with the high demand for capital, make the industry attractive to PE firms.

Most PE firms publicly recognize that the environmental corporate policies of their target companies significantly affect their funds' returns, as shown in online appendix Highlight 7. A common theme of these citations is that reducing pollution and increasing the quality of life for the local population allow PE firms to earn extra risk-adjusted returns. That being said, Sorensen and Yasuda (2022) report that despite the material effects of toxic pollution on shareholder value, little research has investigated the ways in which PE firms affect the environmental policies of their portfolio companies.¹⁶

Another unique feature of the upstream oil and gas sector is the presence of a DrillCo contract, a joint venture between a financial investor and an exploration and production (E&P) company. These contracts do not imply the creation of a new firm, contrary to what the name suggests. DrillCo contracts are highly varied, and their features are limited only by the creativity of the contracting parties. In its basic form, an investor provides cash in exchange for

¹⁶Indeed, as stated by Sorensen and Yasuda (2022): "The empirical evidence on this question [how PE firms affect the environmental practices of their portfolio companies] is currently quite limited, and there is an acute need for more research."

a working interest in a group of wells drilled and operated by the E&P company. Most of the time, a DrillCo contract contains three main components. In each tranche, the investor provides a capital commitment.¹⁷ This capital commitment is used to pay the development costs of the well(s) and part of the E&P working interests in the form of a carry (“carried amount”). In exchange for the capital commitment, the investors acquire a working interest in each tranche. This working interest can be subject to partial reversion once pre-determined internal rate of return (IRR) hurdles are met. More complexity among DrillCo contracts can then be found. For example, the location of the acreage can be made confidential to defend against potential competitors. The DrillCo contract can also contain an alternative plan in case the initial wells are dry. The working interest is defined at the wellbore, but can be depth limited. Another important source of heterogeneity in DrillCo contracts is the timing of the payment, with respect to when the investor transfers the funds and when the operator pays back the investors. The development costs of the well(s) can have a specific limit or, for some deals, a budget can be agreed on.

DrillCo transactions differ in several ways from a traditional PE acquisition. They imply less investor control compared to when an acquisition is made, as described in [Darden and Savage \(2017\)](#). Most operational decisions are undertaken by the E&P company. As Tim Murray from Benefit Street Partners explains: “We don’t micro-manage operational details about how you’re fracking the wells.”¹⁸ Another difference is that unlike in a leveraged buyout, no change in capital structure occurs. Finally, in a DrillCo, PE investor income stems from the working interest in a tranche of wells and does not come from the exit value of the deal. Therefore, DrillCo contracts are financed from PE funds but without any transfers of control rights, change in capital structure, or pressure to exit the investment.

¹⁷In this case, a tranche is a group of oil and gas wells.

¹⁸Nissa Darbonne, “The DrillCo,” in *Oil and Gas Investor, Money Redefined: Capital Formation*, June 2016.

3 Data, Variables, Validation, and Summary Statistics

3.1 Data and variables

3.1.1 Oil and gas datasets

The Ground Water Protection Council and the Interstate Oil and Gas Compact Commission launched FracFocus in April 2011, a database of chemicals used during the fracking process. Disclosure to this database of the chemicals used for each well began as voluntary, but states slowly began to impose mandatory reporting requirements. By 2013, most oil and gas-producing states had instituted mandatory reporting to FracFocus.

FracFocus offers several advantages over the Toxic Release Inventory (TRI) dataset, first by revealing the pollution outcomes of all firms, whereas the TRI is subject to reporting size thresholds ([Khanna \(2019\)](#)). FracFocus also contains a complete list of chemicals in the fracking industry, while the TRI dataset includes reporting for only a selected list of chemicals.

The FracFocus dataset employs a high degree of granularity when collecting the inputs used during oil and gas extraction. The data report information at the well level, such as longitude and latitude, the API14 number (the regulatory ID of the well), the dates upon which the well job started and was completed, and the operator name. The dataset also contains the total number of chemicals used with their CAS numbers, allowing detailed identification of all toxic chemicals present. Operators can report a chemical as confidential, in which case the CAS number will be flagged as confidential.

I merge the API14 number with detailed data from the private vendor Enverus, which provides information on a well's production (for the first six months of oil and gas extraction), its horizontal length, its vertical depth, and the basin in which the well is drilled. The horizontal and vertical dimensions of the well captures the type of technology used (whether it is a horizontal well) and the cost required during the drilling process (larger wells are more costly). Knowing the precise location in which the well is located is important because geographically

close wells are more likely to be drilled in the same rock formation and use the same infrastructure. I exploit a separate dataset from Enverus that collects month-level information on well production and match it to the main database using the API14 number.

3.1.2 Production measures

On average, an oil and gas well produces hydrocarbons over a 20-year lifespan. Over this period, well-production follows a specific decline curve, implying that monthly production is a function of its initial value (Arps (1945)). As a result, my first measure of total well production is its cumulative production of the well in barrels of oil equivalent during its first six months of operation.

The second measure directly models the well output based on canonical Arps decline curves (Arps (1945)), a standard approach in the oil and gas industry. This approach models well production using the following formula: $q_{i,m} = Q_i \cdot (1 + b\theta m)^{-\frac{1}{b}}$. Component $q_{i,m}$ is production for month m of well i . Component Q_i represents the initial rate, b is the degree of curvature of the line, and θ captures the initial decline rate. I take the log of this formula and linearize this equation to estimate parameters using an OLS regression. Finally, I take the resultant equation to compute a well's total estimated production over 20 years.

The reliability of these two measures to capture the total well production is evaluated in Figure 3. When one regresses the predicted production on the realized production, the R2 is 73%. The R2 between realized production and the six-month production equals 71%.

3.1.3 Data on private equity

My source of PE buyout and PE DrillCo comes from Enverus (DrillingInfo) under the product name "Enverus market intelligence." To the best of my knowledge, this paper is the first to use private equity data from Enverus. This dataset offers several advantages over traditional datasets of private equity deals, such as Preqin and Pitchbook. First, Enverus market intelligence records

when a deal is a DrillCo. As this contract is unique to the oil and gas industry, it is often not reported in Preqin and Pitchbook.

Second, Enverus reports the geographic boundaries (shapefiles) of the target company's assets. This information is not reported by Preqin or Pitchbook. The project-level data from FracFocus and Enverus do not contain the company address. Therefore, the target company's shapefiles allow precise identification of its assets in a way that is more reliable than a matching process based on that company's name.

3.1.4 Data on environmental liability risk

I use multiple different measures of environmental liability risk. The first main measure is based on a US Chamber Institute for Legal Reform survey of corporate attorneys about states' liability systems. The survey samples information on how costly a state's liability system is for businesses. It asks questions across multiple dimensions, such as understanding the damages imposed on companies and the overall treatment of tort. Survey data are used to construct a liability score at the state level. The advantage of this measure is that it captures a subjective expectation regarding the potential liabilities that firms can face if they operate in a given location.

The second main measure is whether the well is located in federal or Native American areas regulated by the BLM. In particular, from 2015 through 2018, the BLM faced hurdles in regulating fracking in these areas (see online appendix Highlight 2 for more institutional details). The information for this variable comes from FracFocus. This variable captures the risk of future environmental regulations surrounding fracking activities.

I run several robustness tests using an alternative measure. That measure borrows from the political science literature (Konisky (2007)) and has been applied recently in finance by Seltzer, Starks, and Zhu (2022). I construct a measure of compliance with and enforcement of the Resource Conservation and Recovery Act (RCRA) using data from EPA's RCRAInfo for

hazardous waste sites. The variable enforcement ratio is equal to the number of enforcement actions and inspections taken in a state for a given year, divided by the total entities regulated in the state under RCRA. The enforcement actions include notifications of violations, fines, and administrative orders. A state with a high value of enforcement ratio means that a facility located there is more likely to be subject to RCRA actions. I standardize and normalize the ratio so that the mean equals zero and the variance equals one.

3.2 Summary statistics

3.2.1 Sample

Table 2 reports the additional basic descriptive statistics of the sample, which includes 166,279 US wells fracked from 2012 through 2021 by 1,701 operators. On average, firms use 0.31 toxic components per well and 27% of all the wells use at least one toxic component. Only 6.7% of all wells list at least one confidential item. The wells are also modern: they take on average eight days to complete and are bi-directional. The average sample firm has a total of 97 projects scattered among 11 different locations in 1.37 states. The projects are also scattered across 10.25 locations, which are standardized to six-by-six square miles.

3.2.2 Balance tests

My identification strategy exploits the legal events taking place beginning in 2015 regarding the ability of the BLM to regulate fracking in Native American and federal territories. Therefore, it is crucial to investigate whether the projects drilled in Native American reservations and federal lands were similar to the others before the fracking rule was announced in March 2015. One concern is that contract enforcement or local labor costs would create fundamental differences between the two groups and thus command different usage of toxic pollutants, making causal inferences difficult to obtain.¹⁹

¹⁹Brown, Cookson, and Heimer (2017, 2019) exploit the 1953 enactment of PL280 to create plausibly exogenous variations in the enforcement of contracts within Native American reservations, where litigation was enforced in

Table 3 Panel A shows the raw differences according to whether a well was drilled in Native American reservations and federal lands before 2015. Most characteristics show no differences between projects located in Native American reservations or federal lands and projects located outside those areas. For instance, both groups used almost equal number of toxic chemicals prior to 2015: equal 0.41 for BLM areas and 0.40 for non-BLM areas.

There are two statistically significant differences, but they are not robust to the inclusion of location-year fixed effects. The difference in vertical size becomes negligible (equal to 24.29), and the difference in gas production is almost divided by five once location-year fixed effects are included. This finding is consistent with the idea that location is an important driver in the heterogeneity of projects. Moreover, once the location-year fixed effects are added, most differences in characteristics are reduced by a considerable magnitude.

There are 100 private-to-private PE buyouts, made by 56 different investors. Table 3 Panel B shows that PE firms target companies that do not pollute more than companies never acquired by PE firms. PE firms also target companies that produce less gas and use less advanced technology as proxied by the horizontal length of the wells. Geographic variables drive these differences primarily at the project level. Table A.2 of the online appendix shows the differences in characteristics between companies before they signed a PE DrillCo contract in my sample and those that did not. DrillCo targets are slightly cleaner than the sample non-DrillCo target, although the difference is not statistically significant. DrillCo targets also drill larger projects than non-DrillCo targets, consistent with the idea that they have major capital needs associated with developing their acreages.

Table A.1 of the online appendix investigates the balance tests according to environmental liability measures. Pollution is statistically significantly lower in places with high liability risk. PE firms are slightly less likely to sort to areas with high liability risk, but the difference is economically small and statistically insignificant.

state courts instead of tribal courts for some reservations following the shock. The authors show that this shift affects credit markets, income, financial literacy, and trust. The shocks exploited in this study are different.

3.3 Validation of the dataset

In the online appendix, I report two tests to validate the dataset's quality and lend relevance to variable construction, as described here. The first test, displays in Figure A.1, verifies whether production and pollution are mechanically related (Shapiro and Walker (2018)). The second test, contains in Figure A.2, replicates the known relationship between distress and pollution (Cohn and Deryugina (2018), De Haas and Popov (2019), Levine et al. (2019), Xu and Kim (2022), and Ohlrogge (2023), Bellon and Boualam (2024)).

4 Empirical Design

I estimate the following specification for the chemical i , used by firm k at location j , completed during the year t :

$$Y_{ikjt} = \alpha_k \times \gamma_t + \eta_j \times \gamma_t + \text{Controls}_{ijt} + \beta \cdot (\text{Post Deal}) \times \text{Environmental Liability Risk Measure}_j + \varepsilon_{ijt} \quad (1)$$

The analysis is at the project level and measures the pollution that takes place during the fracking phase, just before the extraction of oil and gas. It implies that we observe the pollution on new investment made at time t . Y_{ikjt} is the measure of pollution, defined at the project level, and Controls_{ijt} includes the first six months of oil and gas production, which are established measures of well production during a well's lifetime.²⁰ I also include horizontal length and vertical depth as additional controls to capture potential time-varying heterogeneity in the type of technology used.

$\alpha_k \times \gamma_t$ is an operator fixed effect interacted with a year fixed effect, which captures any heterogeneity at the firm level that affects the decision to use toxic chemicals. This fixed effect

²⁰Oil and gas production rates decline as a function of time, which means that the first 6 months of production are a good proxy for the overall production of the well (Arps (1945)).

mitigates the selection bias of the portfolio company. For instance, suppose that a company is purchased during a surge in economic activity caused by a decrease in the price of chemicals, thus making the usage of non-polluting chemicals less costly. Therefore, we would observe a decrease in the usage of chemicals after the buyout, which is simply driven by the fact that the chemicals are less expensive now because the buyout took place at a specific moment during industry development.

Moreover, the $\alpha_k \times \gamma_t$ fixed effect helps in isolating the direct impact of PE ownership on pollution. A buyout leads to many significant changes at the firm level, which could create an unintended impact on pollution. For instance, a PE buyout could lead to a technological upgrade for all projects in the company. This technological upgrade could have an unintended effect on pollution. Controlling for $\alpha_k \times \gamma_t$ allows us to absorb the effect of such comprehensive firm-level operational changes.

η_j is a geographical fixed effect equal to one for projects located in places with the same first two digits of latitude and longitude. Figure 2 illustrates such groupings by plotting the wells with the same color if they have the same first two digits of latitude and longitude and are situated in one-half of the Marcellus formation. I interact this Location η_j fixed effect with a year γ_t fixed effect to account for how geographic differences could evolve over time.

Using geographic variables to control for unobserved differences in technology or productivity among projects is a common approach in the literature that uses the fracking industry as an empirical setting (Gilje and Taillard (2016); Gilje, Loutskina, and Murphy (2020)). Indeed, the main source of value creation in the upstream oil and gas industry comes from constructing an acreage, which is a portfolio of lease contracts that provide the right to drill oil and gas within a specific time range and location. The type of rock and its properties –such as its porosity and permeability, and the distance from existing infrastructure (such as pipelines), which increases the cost of flaring– are similar for two wells located in close proximity. Similarly, specific chemical suppliers in the region affect the prices and types of components sold to oil and gas operators. All these variables drive the marginal costs and benefits of polluting and could also

affect the acquisition decision of PE firms. By controlling for these variables, I mitigate the influence of omitted forces that could contaminate the empirical analysis.

Several different measures of Environmental Liability Risk Measure_{*j*} are used in the paper. The first main measure relies on survey data from corporate attorneys about whether the location is exposed to high liability risk. The second main measure exploits different legal shocks that affected areas regulated by the BLM from 2015 through 2018. As a robustness test, I also use information on whether the project is located in a state with a history of high levels of environmental regulatory enforcement.

The coefficient of interests, β , represents the relative effect of a PE deal on the level of pollution when environmental liability risk is high. Roughly speaking, this coefficient is the outcome of a double difference. I first take the difference in project-level pollution between places with high and low environmental liability risk for PE-backed firms. Then, this difference is taken among non-PE-backed firms. Finally, the coefficient gamma is the difference between these two differences once any heterogeneity in location or project characteristics is taken into account. The coefficient gamma measures the extent to which PE-backed firms reduce (if the coefficient is negative) or increase (if the coefficient is positive) pollution when environmental liability risk is high compared to non-PE-backed firms.

5 Results

Subsection 5.1 presents state-level stylized facts with respect to the ways in which PE-backed firms react to environmental liability risk. Subsection 5.2 details a natural experiment to better validate the different sensitivity of firms to environmental liability risk according to their ownership structure.

5.1 State-level measures and stylized facts

5.1.1 Baseline

I start by estimating a slight variation of equation (1), in which I include a firm fixed effect instead of a firm-year fixed effect and include the post effect in a non-interacted way. This variant aims to estimate the direct impact of the PE buyout. Columns (1) and (4) of Table 4 Panel A report results where the dependent variable is, respectively, the number of toxic chemicals and a dummy variable that takes the value 100 if the number of toxic chemicals is above zero and zero otherwise. Overall, PE ownership leads to a considerable reduction in pollution. For instance, companies reduce toxic pollution on new projects in the extensive margin by an average of 16.93 percentage points following the buyout, representing 61.7% of the baseline pollution level.²¹ Many economic channels could generate such a reduction. For instance, PE firms could be less financially constrained (Boucly, Sraer, and Thesmar (2011)). Financial constraint reduces investment, including investment that aims at abating pollution (Cohn and Deryugina (2018), De Haas and Popov (2019), Levine et al. (2019), Xu and Kim (2022)).

To highlight the role of liability risk as a potential force in explaining this result, columns (2), (3), (4), and (5) of Table 4 Panel A estimate equation (1), where the post-buyout dummy is multiplied by the variable Environmental Liability Risk Measure_{*j*}. The first environmental liability risk measure used is *Liability risk* or *High liability risk*. The variable *Liability risk* is the continuous liability score based on the survey measure, and the dummy variable, *High liability risk*, takes the value one if the well is located in a state with a liability score above the sample median value and zero otherwise. The advantage of discretizing the continuous variable *Liability risk* is twofold. It makes the economic magnitude easier to understand and is more robust to measurement errors. Indeed, the assumption that, on average, the liabilities a firm

²¹It is important not to interpret these magnitudes as firm-level changes. Toxic pollution happens during the fracking phase, that takes place for new projects before the extraction of oil and gas.

faces in a place with an above median liability score are greater than the liability faced in an area with a below median liability score is weaker than the assumption that liability increases monotonically with the score.

Overall, columns (2), (3), (4), and (5) of Table 4 Panel A show that pollution reduction is stronger when the well is located in a place with high liability risk. For instance, column (6) suggests that, following the buyout, PE-backed firms reduce pollution by 18.87 percentage points if the well is located in an area with high liability risk. Given that 27.43% of the projects in the sample use at least one toxic chemical, the reduction is economically significant, equal to 68.8% of the baseline usage rate of toxic chemicals.

Table 4 Panel B replicates the exercise, except that the regressions are estimated on a stacked sample, following the approach of Cengiz et al. (2019). PE firms' buyout decisions are staggered. If the causal impact of PE ownership on stakeholders is heterogeneous, then the difference-in-differences estimator is biased. One way to address this potential bias is to estimate the specifications using the stacked sample. Overall, the results of the stacked difference-in-differences remain similar.

Table 5 Panel A and B replicate the baseline specification of Table 4 but focus on another type of deal: a PE DrillCo instead of a PE buyout. In this contract, the company receives equity from a PE investor without any control rights conferred to the PE firm. The direct impact of a PE DrillCo contract on pollution is economically small: only one-third of the effect found in a PE buyout when the dependent variable is the number of toxic chemicals and a reduction of 2.4 percentage points for the extensive margin. Moreover, columns (2), (3), (5), and (6) of Table 5 show that firms under a DrillCo contract are not more sensitive to litigation risks, contrary to the case faced by firms under a PE buyout. Although some results are statistically significant at the 5% or 10% threshold when the dependent variable is the number of toxic chemicals, this effect is not robust to the stacked regressions, as displayed in the Table 5 Panel B. These findings are consistent with the view that pollution reduction is driven by the PE firm's ability to control the target company's management team. The ability to influence managers is possible in a buyout

but not in a DrillCo contract, as a buyout confers substantial control rights over the portfolio company to the PE firm.

I run specification curves to show how one control affects the point estimates transparently by running 128 regressions with different inclusions/exclusions of controls and fixed effects. I follow an approach similar to [Simonsohn, Simmons, and Nelson \(2019\)](#); [Cookson \(2018\)](#); and [Akey, Heimer, and Lewellen \(2021\)](#). Figure 7 shows the specification curves for the direct impact of PE buyouts. The point estimates range from -18 to -16.32 when the dependent variable is a dummy variable that takes the value one if the well uses toxic chemicals and zero otherwise. When the dependent variable is the number of toxic chemicals, the interaction coefficients post-buyout with the high-liability risk dummy range from -0.25 to -0.23.

Figure 8 reports the specification curves as a function of liability risk. The point estimates range from -18 to -16.32 and -0.24 to -0.23 when the dependent variable is a dummy variable that takes the value one if the well uses toxic chemicals and zero otherwise; and the number of toxic chemicals, respectively.

Several findings are worth noting from the specification curve exercise. First, project-level characteristics, such as the technology used (measured by the horizontal and vertical dimensions of the project) or the production of the well (proxied by the first six months of oil and gas production), do not change the point estimates in an economically meaningful way. This result is consistent with the view that the fixed-effect approach of this paper captures a critical component of project-level heterogeneity between PE-backed firms and non-PE-backed firms. For instance, the hyper-local area fixed effect captures differences in project-level productivity between firms in those two groups. This result is consistent with the findings of [Gilje, Loutskina, and Murphy \(2020\)](#), who find that geographic variables attenuate the difference in productivity between firms with high and low leverage.

Second, excluding those controls responsible for large variations in the point estimates leads to underestimation of the effect. For instance, in Figure 7, the coefficient is the strongest in absolute value when all the controls are included.²²

Figure 5 plots the coefficient dynamic around a PE buyout in a stacked difference-in-differences specification. I construct this figure by estimating equation (1) with a firm fixed effect instead of a firm-year fixed effect and by including indicators for each semester around the buyout. The dependent variable of Panel A is the number of toxic chemicals. The dependent variable of Panel B is an indicator that takes the value 100 if the well uses at least one toxic component and zero otherwise.

Figure 6 plots the coefficient dynamic around a PE buyout as a function of liability risk in a stacked difference-in-differences specification. Specifically, it plots the coefficient of equation (1) where the set of semester indicators around the buyout is multiplied by the variable *High liability risk*.

Figures A.5 and A.6 replicate both types of dynamic graphs, but instead of focusing on the PE buyout, I look at PE DrillCo. We can observe a precise zero effect of PE DrillCo on pollution.

While the common trend assumption cannot be directly tested, I then run several tests developed by Roth (2022) to assess the possibility of having a pre-trend driving the results in Figures A.3, A.4, A.7, and A.8 of the online appendix. In particular, I add the plot of the hypothesized trend with a power threshold of 80% to the previous dynamic event study. I also plot what the coefficients should look like conditional on not finding a significant pre-trend if the true pre-trend was the hypothesized trend. These coefficients are almost always outside the pre-period confidence intervals, bringing more confidence to the idea that a pre-trend is not driving the

²²In a standard difference-in-differences specification, the post variable is interacted with a group variable, but the post and group variable are directly included in the specification when they are not strictly colinear with the fixed effect. The group variable, in our case, is whether the project is located in a place with high environmental risk. This group variable is strictly colinear with the state-year fixed effect. When I do not include the state-year fixed effect in the specification curves, I include instead the group variable—that is, whether the state has high liability risk—in the specification.

results. Moreover, I show different statistics, reported in Table A.13 of the online appendix, such as the likelihood ratio or Bayes ratio, that confirm this graphical evidence. These statistics are low and close to zero, consistent with the absence of a statistically significant pre-trend. Finally, Table A.14 of the online appendix reports a sensitivity analysis based on smoothness restrictions following Rambachan and Roth (2023). I assume that the slope of the pre-trend can change by no more than the average difference in pollution within firms in the full sample, across consecutive periods. The average difference in pollution within firms in the extensive margin is 0.133, and the average difference in the number of toxic chemicals used within firms is (in absolute value) 0.0018. The main conclusions hold.

In the online appendix, I show that the results are robust to using different proxies for liability risk. Table A.10 focuses on PE buyouts, while Table A.11 relies on DrillCo contracts. Columns (1) and (3) of Table A.10 and Table A.11 include a dummy variable that takes the value one if the measure of compliance and enforcement is above the sample median and zero otherwise. This measure of compliance and enforcement borrows from the political science literature (Konisky (2007)) and has been applied recently in finance by Seltzer, Starks, and Zhu (2022). Finally, columns (2) and (4) multiply all the liability proxies simultaneously. The locations defined as risky are thus consistently identified as risky, irrespective of the proxy employed. Overall, the results remain robust in all the specifications: we observe an economically meaningful and statistically significant drop in pollution following a PE buyout, while the pollution levels are unaffected by a PE DrillCo.

5.2 Natural experiment

Although the previous results are informative, one cannot rule out the possibility of a selection bias between PE ownership and pollution or their exposure to environmental liability risk. To better validate the interpretation that PE-backed firms are more responsive to legal changes

affecting the liabilities they face, I exploit a natural experiment that plausibly exogenously changes the environmental liability risk for some areas but not others.

Another measure of environmental liability risk occurs outside of state legislation and takes place within a state boundary. As shown in the previous section, these areas are federal and Native American lands, which had been subject to lower environmental liability risk from 2015 through 2018 following a succession of political and legal events. Online appendix Highlight 2 details the events and their institutional context.

I first plot the differences in pollution generated each year, between PE-backed firms located in BLM and non-BLM areas. I estimate more parameters when constructing the dynamic event study graphs for the natural experiment. During this step, however, I cannot include all the controls present in the baseline specification without decreasing the sample size. Therefore, I estimate different combinations of the controls in the dynamic graph to avoid over-controlling. Specifically, Figure 10 plots the point estimates of the following equation for different fixed effects FE_{it} :

$$Y_{ikjt} = FE_{it} + \sum_{\tau=2012}^{2019} (\text{year}=\tau) \times (BLM)_i \times \theta_{\tau} + X_{it} + \varepsilon_{ijt} \quad (2)$$

where (BLM) is a dummy variable that takes the value one if the project is located on federal or Native American lands regulated by the BLM and zero otherwise. The reference year is 2014, the year before the shock occurs. Specification (1), represented by a triangle, includes a location, firm, and year fixed effect. Specification (2) does not include any fixed effect and is represented by a square. Specification (3) includes a location and firm fixed effect and is represented by a circle.

As seen in Figure 10, pollution increased in areas regulated by the BLM from 2015 through 2017. The legal response of the state of California following the rescission of the 2015 rule implies a non-statistically significant increase in pollution for the years after 2018, supporting

the view that this legal response was credible in creating higher future environmental liabilities for operators. The point estimate is positive for 2015, but is lower, consistent with the view that the 2015 preliminary injunction was not a permanent court decision. Indeed, a preliminary injunction is a temporary decision that preserves the status quo until the courts decide on a case. Moreover, the dynamic plots suggest that the effect had not been driven by a pre-trend before 2015.

I then estimate a variant of equation (1), in which I use the variables $(BLM)_i \times 2017$ or $(BLM)_i \times \text{Federal court ruling}$. The first variable is an interaction term between the BLM dummy and a dummy variable that takes the value of one if the well was drilled in 2017—the year when the fracking rule was voided by the Trump administration—and zero otherwise. The second variable is also an interaction term between the BLM dummy and the Federal court ruling dummy variable. The Federal court ruling variable equals one if the well has been drilled between September 30, 2015, and January 24, 2018, and zero otherwise. Respectively, these two dates correspond to when the preliminary injunction that challenged the fracking rule was granted by the Federal Court of the Tenth Circuit and when the state of California and a group of environmental activists sued the BLM for voiding the rule.

Table 6 contains the results. Overall, they show an increase, both on the extensive and intensive margins, in pollution when environmental liability risk is low. The effects are stronger in 2017, when the Trump administration voided the rule. The economic magnitudes of the effects are meaningful: PE-backed firms increase by 43.83% the usage of at least one toxic chemical for their new wells in locations where environmental liability risk is low, compared to new wells in places that do not experience a change in environmental liability risk and compared to non-PE-backed firms. Overall, the results of this shock validate the previous state-level findings that PE-backed firms reduce (increase) the release of toxic chemicals when the environmental liability risk attached to this practice is higher (lower).

I run 256 distinct regressions to construct the specification curves and investigate the robustness of the results, shown in Figure 9. The point estimates are stable when the combination

of controls varies. Specifically, the estimates range from 0.55 to 0.57 for the number of toxic chemicals and from 49.12 to 50.55 for the variable $100 \times \text{number of toxic chemicals} > 0$, with an average of 0.56 and 49.83, respectively. Accounting for project-level characteristics does not affect the estimated coefficients in an economically meaningful way.

Native American reservations use a different legal system and rely on tribal courts. This difference could make the control and treatment groups noncomparable. The reliance of the empirical setting on the common trend assumption and its use of time-varying variations in environmental liability risk mitigates this concern. As an additional robustness test, I replicate the natural experiment specification by focusing only on federal land in Table A.9 of the online appendix. Overall, the results remain similar in sign and economic magnitudes: PE-backed firms increase by 47.04% the usage of at least one toxic chemical when environmental liability risk is low.

6 Robustness Tests

In this section, I investigate different alternative explanations of the results above.

Production. Figure A.1 of the online appendix shows that production and pollution are mechanically related, confirming a result shown in the literature (Shapiro and Walker (2018)). A change in production could drive one alternative explanation of the effect of PE ownership on pollution. In particular, PE-backed firms could produce less when legal liabilities are higher or increase production when these legal liabilities diminish.

Table 7 Panel A replicates the baseline specifications, except that the dependent variable is a production measure. I use two different variables for production. Columns (1) through (4) use the first six months of production, while columns (5) through (8) rely on estimated well production using the Arps decline curve as described in Figure 3. Columns (1) and (5) show that production increases following the buyout. This result is consistent with previous

literature, showing that private-to-private buyouts lead to increased production (Boucly, Sraer, and Thesmar (2011)). Columns (2) and (6) add geographical fixed effects and technological controls. The point estimate is greatly diminished, suggesting that this increase in production by PE-backed firms is driven by changes in the technology employed, as proxied by well horizontal length and vertical depth, and also by the choice of well location. Columns (3), (4), (7), and (8) investigate whether changes in production vary according to the proxies of legal liabilities. Overall, the point estimates are close to zero and statistically non-significant, consistent with the view that changes in production do not drive the effects on pollution. Finally, Table 7 Panel B investigates whether changes in production drive the effects of the natural experiment tests. Similarly, no increase in production occurs when environmental liabilities are lower.

In the online appendix, I run additional tests to investigate whether a change in production drives the effect of PE buyouts on pollution. Specifically, I match all the observed monthly production data to the pollution sample. I replicate the baseline specifications on this new sample and control for production at a high-frequency level. I include as a control the monthly production in a polynomial. Table A.5 contains the results. Overall, the results on pollution remain the same when high-frequency production controls are included in the sample.

Confidential chemicals. Companies can report a toxic chemical as confidential if the component is a trade secret, which is one potential way to avoid reporting it. Toxic chemical use is not forbidden, so companies face no direct cost to report it and therefore have limited incentives to misreport usage. Table 8 replicates the baseline specifications, except that the dependent variable is either the number of confidential items reported in the well or a dummy that takes the value one if the operator reports at least one confidential item in the well and zero otherwise. Table 8 shows that firms' reporting practices do not change with PE buyouts and are not sensitive to the liability regimes, as the coefficients are statistically non-significant and close to zero.

The online appendix includes the results of additional tests that investigate whether a change in reporting practice drives the effect of PE buyouts on pollution. The first test relies on the extreme assumption that all confidential items are toxic chemicals. Table A.3 reports the results. Although the measure is more noisy, the results remain similar. Further testing includes a confidential item-year fixed effect in the baseline regressions. Table A.4 reports the results. The point estimates are very close to those that result when the controls are not included, consistent with the idea that a change in reporting practices does not drive the results.

Different definitions of toxic chemicals. I investigate the robustness of the results to different classifications of toxicity. First, I use the EPA list of extremely hazardous substances (defined in Section 302 of the US Emergency Planning and Community Right-to-Know Act (42 USC 11002)). The Local Emergency Planning Committee uses this list to design emergency and evacuation plans in case of toxic contamination. Table A.6 contains the results when this novel classification of toxicity is used as a dependent variable. Overall, the results are similar. Second, I rely on the chemicals identified as harming human health in the EPA's Integrated Risk Information System (IRIS). This list is constructed using scientific research to identify and characterize the health hazards of chemicals found in the environment. I focus on chemicals that alter a biological system or increase cancer risks. Table A.7 reports the results and validates the main findings. The results are similar. Moreover, it is important to highlight that measurement errors in the classification will introduce exogenous noise, thus bringing the coefficients close to zero. In case of exogenous measurement error in the chemical classifications, the magnitudes reported should be interpreted as a lower bound of the true effect of PE ownership.

Econometric variations. Table A.8 shows that the results hold when I use a Poisson estimation methodology. Table A.12 shows that the results are robust to two-way clustering of the standard errors at the firm and location level.

7 Conclusion

This paper shows that PE-backed firms, in private-to-private buyouts, are more likely to increase (decrease) pollution when facing lower (higher) legal liability risk. On average, PE-backed firms decrease the usage of at least one toxic chemical by 68.8% of the baseline rate for every new project located in a state with high legal liability risk. I confirm these state-level stylized facts by exploiting plausibly exogenous legal and political shocks that reduced the ability of the Bureau of Land Management to regulate fracking among Native American and federal lands. Using these shocks and comparing projects in adjacent areas, I find that PE-backed firms increase pollution by 43.83% during the fracking stage when environmental liability risk is low.

These results are consistent with the view that PE firms change the governance of their target companies and take actions that enhance shareholder value. In particular, these actions are part of the operational engineering channel, wherein PE firms develop industry and operating expertise ([Gompers, Kaplan, and Mukharlyamov \(2016\)](#)). The results support the view that the legal knowledge of PE firms is part of this operating expertise, as PE firms respond more to the legal liability risk created by governments' enforcement and regulation activities.²³

Overall, PE ownership leads to heterogeneous environmental corporate policies that depend on the legal liability risks their projects face. This study is the first to show the role of those risks in understanding the operational consequences of PE buyouts and how they affect stakeholders' welfare. However, it remains unclear how externally valid this channel is for other contexts and settings. Future work might study the role of legal liability in understanding the consequences of PE buyouts for different stakeholders or industries.

²³Providing a microfoundation for why PE-backed firms develop operating expertise, as stated in [Gompers, Kaplan, and Mukharlyamov \(2016\)](#) for instance, is outside the scope of this paper. That said, section 7 of the online appendix discusses several theories that could explain this result as an equilibrium outcome.

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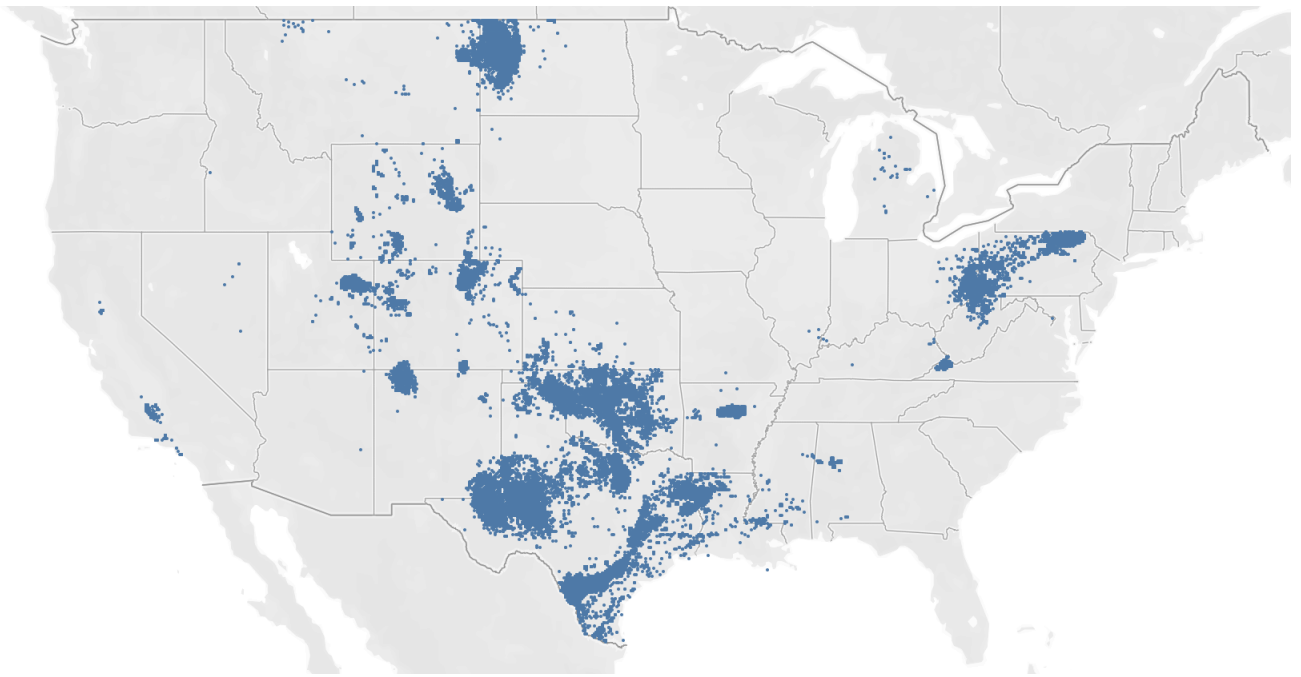
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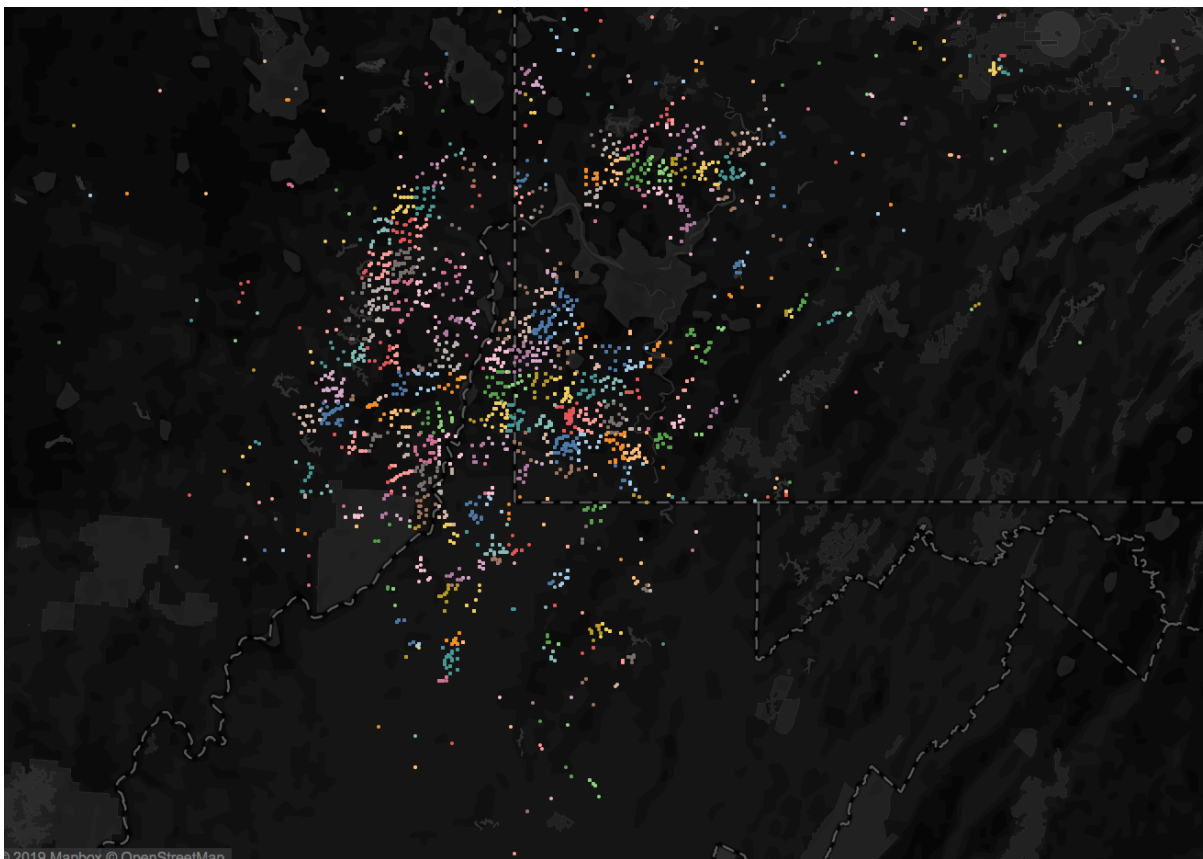
Tables / Figures

Figure 1: Distribution of Projects



Note: This figure shows the location of the projects used in the statistical analysis.

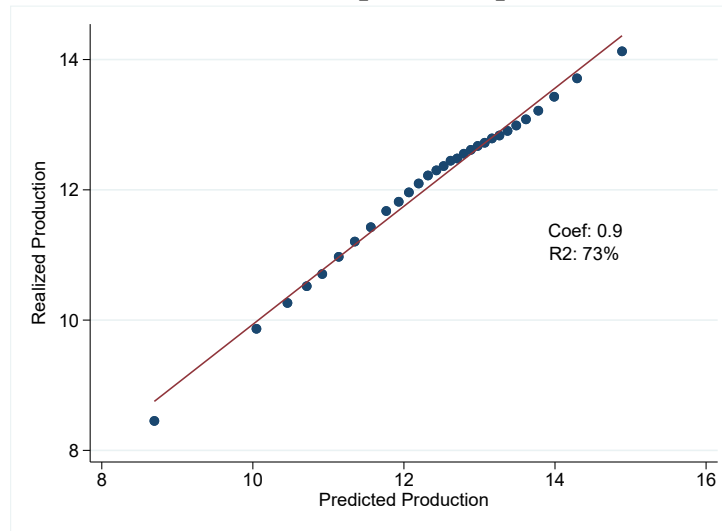
Figure 2: High-frequency Geographical Fixed Effect: Geographical Example Using the Marcellus Formation



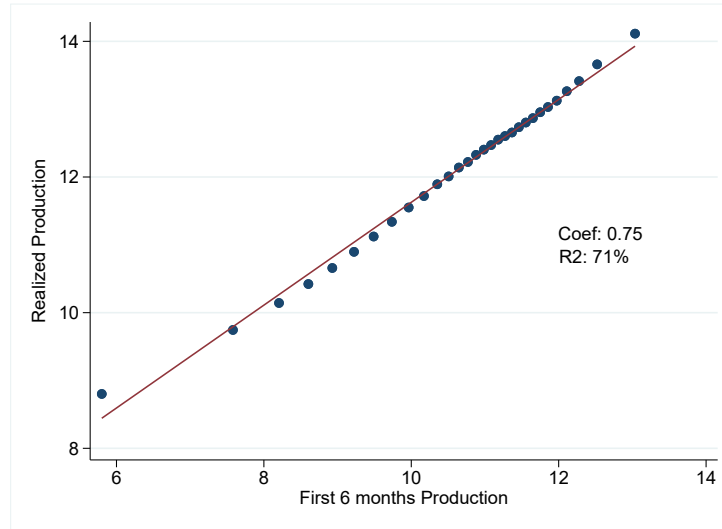
Note: This map illustrates the coarser geographical fixed effect after zooming in on the Marcellus formation. Each color identifies a single location used to create the fixed effect.

Figure 3: Measures of Production

A. Realized versus predicted production



B. First 6 months versus total production

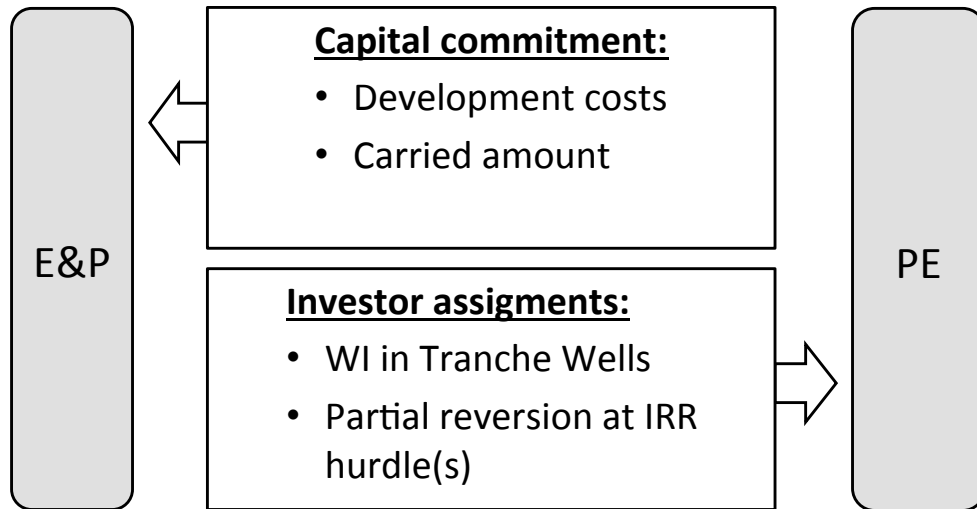


Note: The production of a well is extracted over a period that averages 20 years. Not all well production is extracted and thus observed directly. I estimate classical Arps decline curves to calculate a proxy for total well production. Specifically, I estimate the following specifications, for each well j that has an age (in month) of m :

$$\log(\text{Production})_{jm} = \theta_1 \times D_{m=1} + \theta_2 \times D_{m=2} + \theta_3 \times m + \theta_4 \times m^2 + \theta_5 \times m^3 + \theta_6 \times m^4 + \theta_7 \times m^5 + \text{Firm}_j \times \text{Year}_t + \text{State}_j \times \text{Year}_t + \text{Location} \times \text{Year}_t + \varepsilon_{im}$$

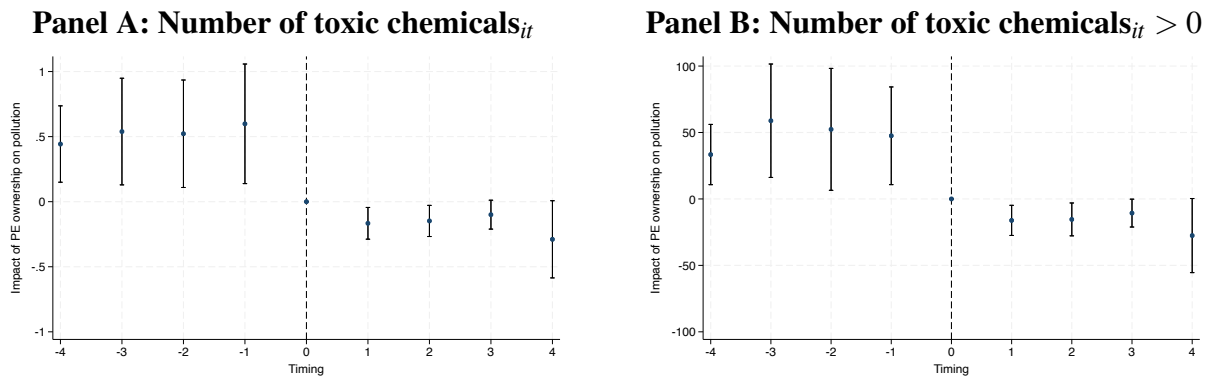
where $D_{m=1}$ is a dummy variable that takes the value one if the month m is equal to 1, zero otherwise. Similarly, $D_{m=2}$ is a dummy variable that takes the value one if the month m is equal to 2, zero otherwise. $\theta_{k=1,\dots,7}$ are estimated coefficients; $\text{Firm}_j \times \text{Year}_t$, $\text{State}_j \times \text{Year}_t$, $\text{Location} \times \text{Year}_t$ are firm-year, state-year, and location-year fixed effects, respectively. I estimate the model for oil production and gas production separately, then add the predicted values. The unit of production is the barrel of oil equivalent (BOE).

Figure 4: Structure Of a DrillCo Deal



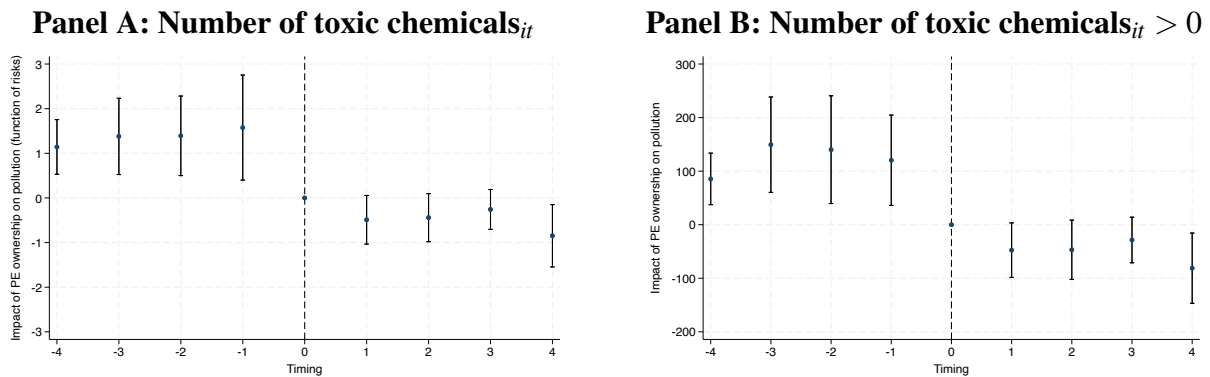
Note: This figure summarizes the structure of a DrillCo deal between a private equity (PE) firm and an exploration & production (E&P) company.

Figure 5: Event Study around a PE Buyout: Overall Effect



Note: Panels A and B show the dynamic graph of the average pollution around a PE buyout in the difference-in-differences specifications. The specifications are estimated in the stacked panel, following the approach of [Cengiz et al. \(2019\)](#). I replicate the difference-in-differences specifications wherein the main coefficient of interest is estimated through different time dummies. Specifically, both panels plot the event-study of the net effect of PE ownership on pollution, in a difference-in-differences specification, that includes a firm, state-year, and location fixed effects, and production and technology controls. These fixed effects are interacted with a cohort fixed effect. The dependent variable of the specification in Panel B is “Number of toxic chemicals_{it}”, the number of toxic chemicals used during the fracking phase. Panel A shows the results of the same specification, except that the dependent variable is “Number of toxic chemicals_{it} > 0”, a dummy that takes the value 100 if the firm uses at least one toxic chemical during the fracking phase and zero otherwise.

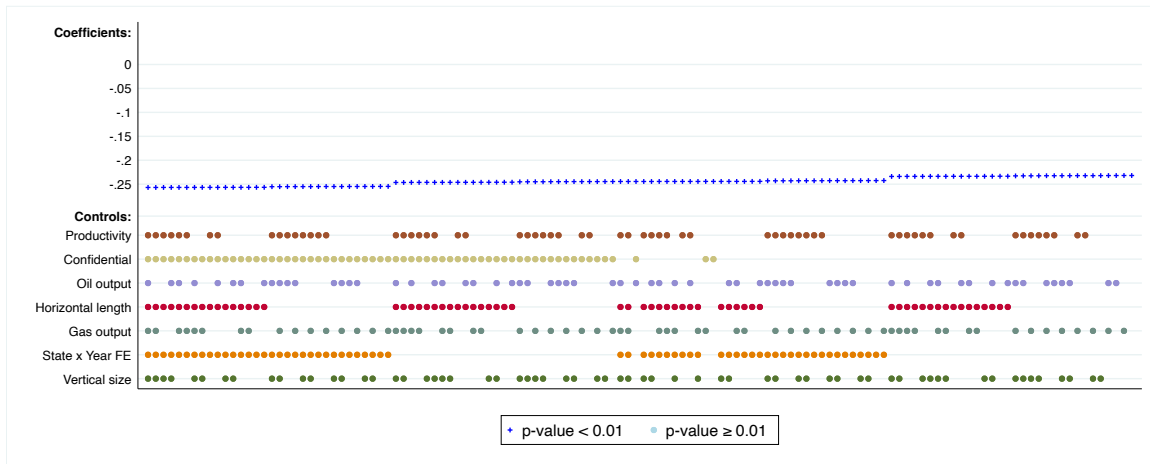
Figure 6: Event Study around a PE Buyout: Liability Risk



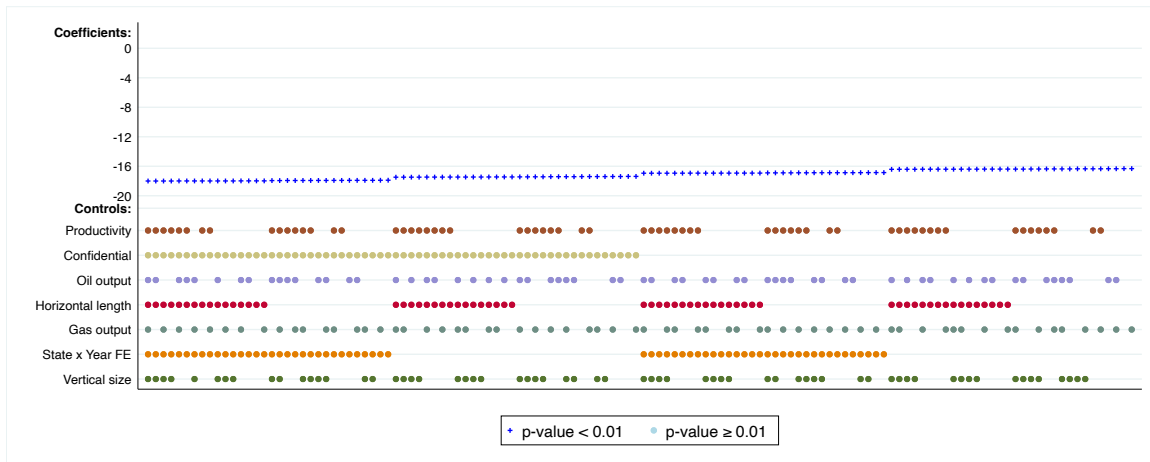
Note: These panels show the dynamic graph of the average pollution around a PE buyout in difference-in-differences specifications as a function of liability risk. The specifications are estimated in the stacked panel, following the approach of Cengiz et al. (2019). I replicate the difference-in-differences specifications wherein the main coefficient of interest is estimated through different time dummies. Specifically, both panels show the impact of PE ownership as a function of environmental liability risk. Technology and production controls are included, and firm-year, state-year and location fixed effects are added in all specifications. These fixed effects are interacted with a cohort fixed effect. The dependent variable of Panel A is “Number of toxic chemicals_{it}”, the number of toxic chemicals used during the fracking phase. The dependent variable of Panel B is “Number of toxic chemicals_{it} > 0”, a dummy that takes the value 100 if the firm uses at least one toxic chemical during the fracking phase and zero otherwise.

Figure 7: Specification Curves (1/3)

Panel A: Number of toxic chemicals



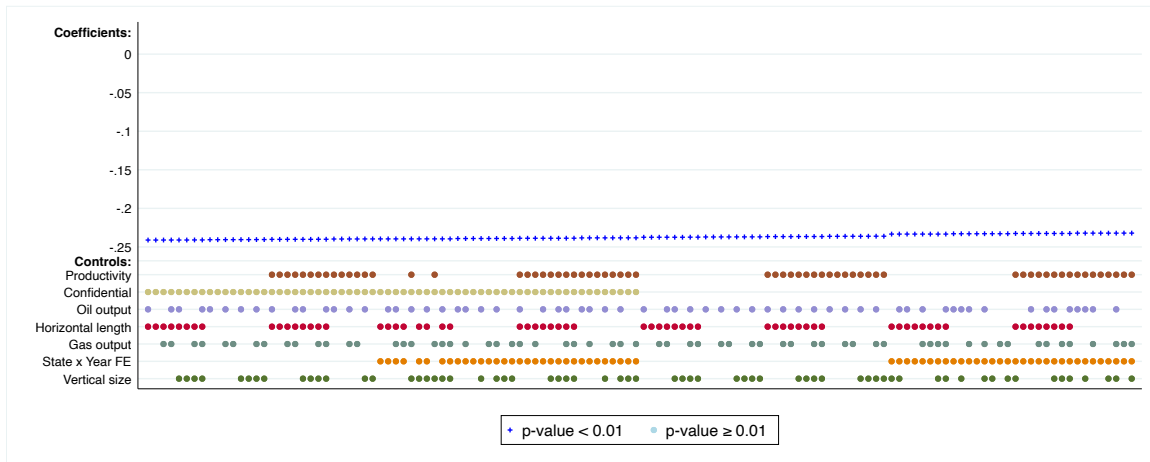
Panel B: Number of toxic chemicals > 0



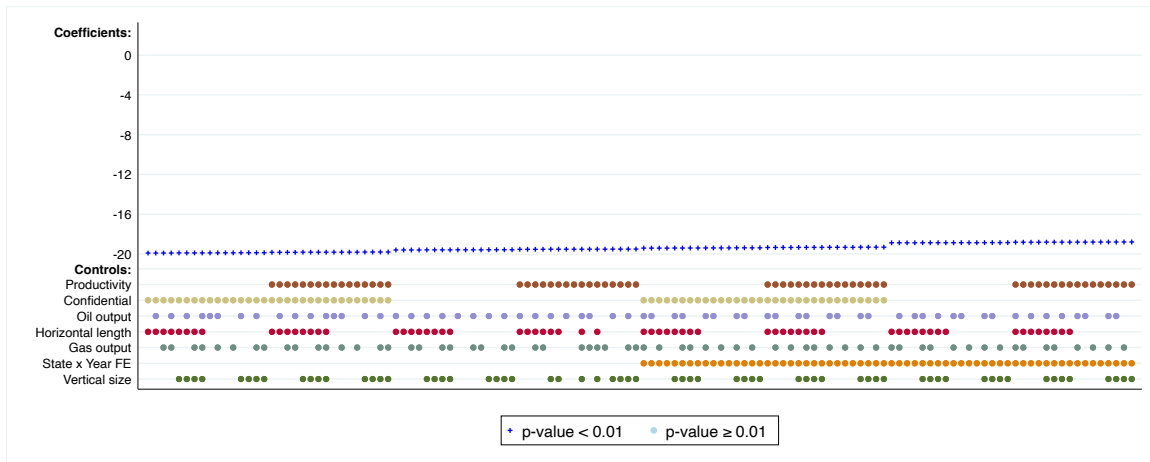
Note: These panels depict the specification curves of the baseline estimations. The dependent variable of Panel A is the number of toxic chemicals used during the fracking phase. The dependent variable of Panel B is a dummy variable that takes the value 100 if the firm uses at least one toxic chemical, and zero otherwise. The graphs report the coefficients of the direct effects of PE buyout on pollution and thus display the point estimate of the coefficient Post buyout_{it} , when different controls are included. All specifications include Location $\text{FE}_j \times \text{Year FE}_t$ and Firm FE_i fixed effects.

Figure 8: Specification Curves (2/3)

Panel A: Number of toxic chemicals



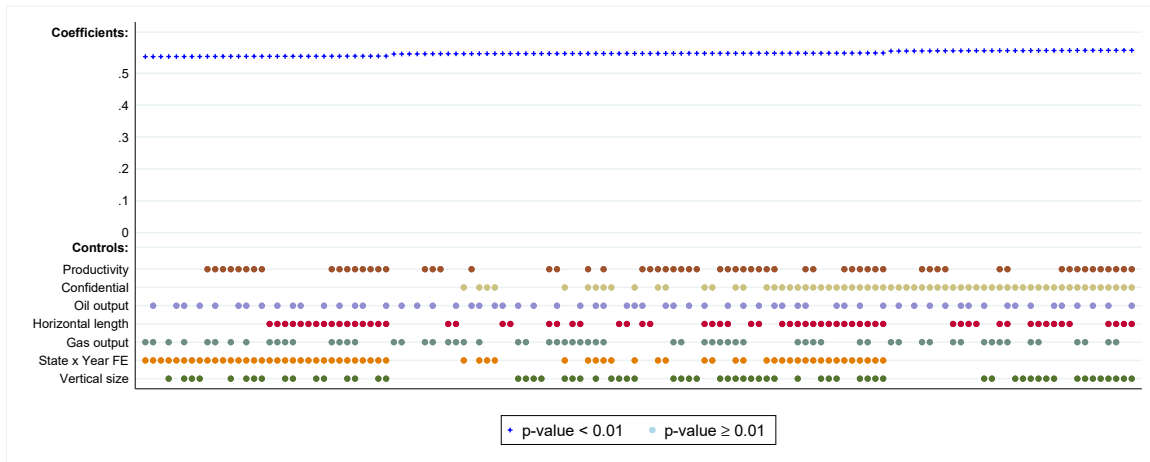
Panel B: Number of toxic chemicals > 0



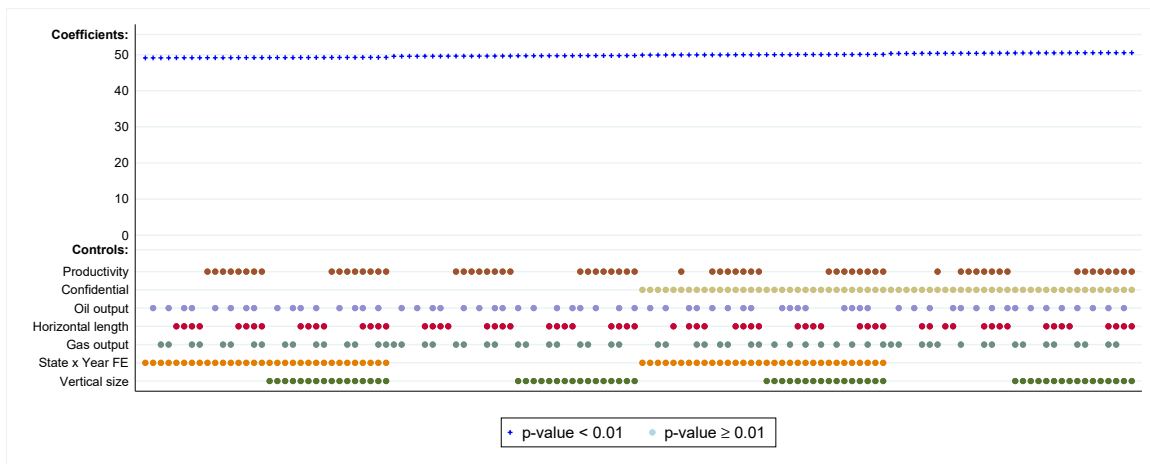
Note: These panels depict the specification curves of the baseline estimations. The dependent variable of Panel A is the number of toxic chemicals used during the fracking phase. The dependent variable of Panel B is a dummy variable that takes the value 100 if the firm uses at least one toxic chemical, and zero otherwise. The graphs report the point estimate of the interaction coefficient $\text{Post buyout}_{it} \times \text{High Liability}$, when different controls are included. All specifications include $\text{Location FE}_j \times \text{Year FE}_t$ and $\text{Firm FE}_i \times \text{Year FE}_t$ fixed effects.

Figure 9: Specification Curves (3/3)

Panel A: Number of chemicals

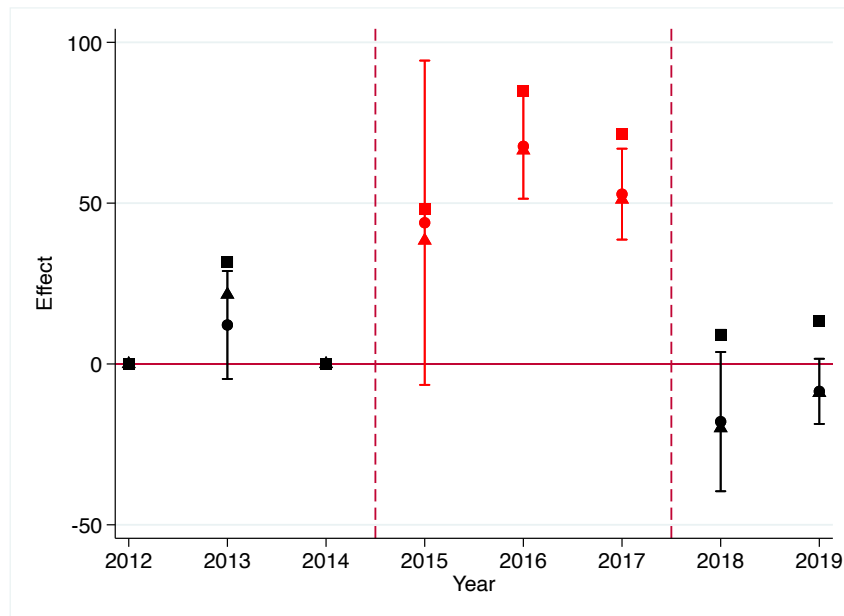


Panel B: Number of chemicals > 0



Note: These panels depict the specification curves of the natural experiment, when the ability of the BLM to regulate fracking is reduced. The dependent variable of Panel A is the number of toxic chemicals used during the fracking phase. The dependent variable of Panel B is a dummy variable that takes the value 100 if the firm uses at least one toxic chemical, and zero otherwise. The graphs report the point estimate of the interaction coefficient $\text{Post buyout}_{it} \times \text{BLM} \times 2017$, when different controls are included. All specifications include Location $\text{FE}_j \times \text{Year FE}_t$ and Firm $\text{FE}_i \times \text{Year FE}_t$ fixed effects.

Figure 10: Impact of Decreased Liability Risk



Note: This figure shows the dynamic event windows of the difference-in-differences specifications on how PE-backed firms reacted to changes in BLM authority to regulate fracking in federal lands and Native American reservations. I estimate the following specification for different fixed effects:

$$Y_{ijt} = FE_{it} + Post_t + BLM_i + PE-backed_i + Post_t \times BLM_i + PE-backed_i \times BLM_i \quad (2)$$

$$+ PE-backed_{it} \times Post_t + \sum_{\tau=2013}^{2019} (year=\tau) \times (BLM)_i \times PE-backed_{it} \times \theta_{\tau} + X_{it} + \varepsilon_{ijt}$$

Specification (1), represented by a triangle, includes location, firm, and year fixed effects. Specification (2) does not include any fixed effect and is represented by a square. Specification (3) includes location and firm fixed effects and is represented by a circle. The ability to regulate fracking within BLM areas was reduced from 2015 through 2017. The period includes the time when the preliminary injunction was granted, the rule was stricken down by the district of Wyoming, and the rule was voided by BLM (December 29, 2017) following the Trump administration policy. Finally, the period from January 24, 2018 through 2019 corresponds to the time during which the State of California sued BLM for its decision to rescind the rule.

Table 1: Definition and Source of Toxic Chemicals

Chemical name	CAS number	Toxicity
2-butoxyethanol	111-76-2	causes hemolysis (destruction of red blood cells), spleen, liver, and bone marrow.
Xylene	1330-20-7	human carcinogen, SDWA, CAA
Toluene	108-88-3	human carcinogen, SDWA, CAA
Ethylbenzene	100-41-4	human carcinogen, SDWA, CAA
Benzene	71-43-2	human carcinogen, SDWA, CAA
Bis(2-ethylhexyl) phthalate	117-81-7	human carcinogen, SDWA, CAA
2-Propenamide	79-06-1	human carcinogen, SDWA, CAA
Copper	7440-50-8	human carcinogen, SDWA, CAA
Lead	7439-92-1	human carcinogen, SDWA, CAA

Note: This table reports the chemicals used as our main dependent variable. They have in common both high toxicity and salience, as given in environmental reports as well as reports from the United States House of Representatives Committee on Energy and Commerce (e.g., April 2011). Most are regulated at the federal level, but hydraulic fracturing benefits from several exemptions: this industry is subject neither to the Safe Drinking Water Act (SDWA) nor to several permitting and pollution control requirements from the Clean Air Act (CAA). Human carcinogens are substances that promote cancer formation. A contamination caused by these chemicals exposes the oil and gas company to environmental liabilities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Table 2: Descriptive Statistics**Panel A: Descriptive statistics, full sample (project level)**

Variable	Mean	Std	p10	p90
Number of toxic chemicals _{it}	0.319	0.564	0	1
Number of toxic chemicals _{it} > 0	27.429	44.616	0	100
Liability risk	37.311	6.205	29.300	43.700
PE buyout targets	0.036	0.187	0	0
PE DrillCo targets	0.113	0.316	0	1
BLM	0.064	0.245	0	0
Months to Production	8.322	25.700	0	20
Horizontal length	5,014.021	4,133.054	0	10,376.810
Vertical depth	8,341.202	3,220.889	4,184	11,860
First 6 oil	34,196.967	47,745.777	0	10,0758
First 6 gas	242,646.313	53,6542.120	0	58,9502
Number of confidential items	0.067	0.251	0	0
Number of confidential items>0	0.068	0.251	0	0
Observations	166,279			

Panel B: Descriptive statistics, full sample (firm level)

Variable	Mean	Std	p10	p90
Projects	97.754	457.506	1	128
States	1.512	1.255	1	2
Locations	10.253	32.225	1	19
Observations	1,701			

Note: These panels report the baseline descriptive statistics. Panels A and B report information for the full sample at the project and firm level, respectively. “PE buyout targets” is a dummy variable that takes the value one if the operator is purchased, at some point, by a PE firm and zero otherwise. The variable “PE DrillCo targets” is a dummy variable that takes the value one if the operator, at some point, signs a DrillCo contract with a PE firm and zero otherwise. The variable “Months to Production” measures the time (in days) to drill the well, and is the difference between the initial drilling date (spudding) and its completion date, during which time the casing, cementing, and hydraulic fracturing of the well are completed.

Table 3: Balance Tests**Panel A: Descriptive statistics before the 2015 shock comparing BLM and non-BLM areas**

Variables	BLM Areas	Non-BLM Areas	Diff.	S.D.	Adj-diff	Adj-S.D.
Number of toxic chemicals _{it}	0.41	0.40	0.0130	0.0395	0.0708	0.0440
(Number of toxic chemicals _{it} > 0)	37.58	34.46	3.120	3.505	5.276	3.459
PE buyout targets	0.06	0.05	0.0179	0.0321	0.0115	0.00921
PE DrillCo targets	0.09	0.11	-0.0189	0.0250	0.00352	0.00675
Months to Production	11.12	12.02	-0.906	0.786	0.915*	0.373
Horizontal length	6,187.75	6,376.84	-189.1	528.3	237.7*	103.5
Vertical depth	9,286.04	8,476.31	809.7**	259.1	-24.29	92.05
First 6 gas	221,877.9	324,662.34	-102,784.4*	41,349.2	-21,713.6	13,449.2
First 6 oil	55,913.81	45,515.07	10,398.7	6,331.9	1,768.1	1,979.4
Number of confidential items	0.05	0.04	0.0107	0.0185	-0.00391	0.00539
Number of confidential items>0	0.05	0.04	0.0107	0.0185	-0.00391	0.00539

Panel B: Descriptive statistics (project level) before the PE-buyout

Variable	Group treated	Control group	Diff.	S.D.	Adj-diff	Adj-S.D.
Number of toxic chemicals _{it}	0.25	0.32	-0.0644	0.0844	0.0275	0.0491
Number of toxic chemicals _{it} >0	18.64	27.14	-8.496	6.424	-2.307	3.583
High liability risk	0.63	0.6	0.0273	0.124	Absorbed	.
Liability risk	37.63	37.37	0.26	1.885	Absorbed	.
Months to Production	4.85	8.32	-3.473**	1.681	0.648	0.805
BLM	0.01	0.06	-0.0554***	0.00914	-0.0225*	0.0121
Horizontal length	3,955.61	5,007.09	-1,051.5	1,108.9	156.9	230.4
Vertical depth	9,264.66	8,332.18	932.5	665.2	-33.92	66.82
First 6 oil	20,515.23	34,434.5	-13,919.3***	5,089.5	-1,000.9	1,386.1
First 6 gas	165,362.97	242,310.85	-76,947.9	63,679.3	-2,254.1	18,840.5
Number of confidential items _{it} > 0)	0.14	0.07	0.0681	0.0501	0.0653**	0.0253
Number of confidential items _{it}	0.14	0.07	0.0681	0.0501	0.0653**	0.0253

Note: These panels report the balance statistics. Panel A shows the descriptive statistics comparing areas regulated by the Bureau of Land Management (BLM) with those that are not, prior to 2015. Panel B shows the difference in characteristics between companies targeted by PE firms and those that are never acquired by a PE firm. Adjusted differences are the difference once the fixed effects of the baseline estimations are included. Standard errors are clustered at the firm level. “PE buyout targets” is a dummy variable that takes the value one if the operator is purchased, at some point, by a PE firm and zero otherwise. Similarly, “PE DrillCo targets” is a dummy variable that takes the value one if the operator, at some point, signs a DrillCo contract with a PE firm and zero otherwise. The variable “Months to Production” measures the time (in days) to complete the well, and is the difference between the initial drilling date (spudding) and its completion date, during which time the casing, cementing, and hydraulic fracturing of the well are completed.

Table 4: Baseline Results: PE Buyout**Panel A: Full sample**

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.244*** (0.0838)			-16.93*** (5.368)		
Post buyout _{it} × Liability risk		-0.00507*** (0.00122)			-0.418*** (0.0949)	
Post buyout _{it} × High liability risk			-0.233*** (0.0442)			-18.87*** (3.844)
Vertical depth _{it} (std)	0.00259 (0.00426)	0.000249 (0.00389)	0.000209 (0.00390)	0.294 (0.299)	0.122 (0.284)	0.118 (0.284)
Horizontal length _{it} (std)	0.00950 (0.00590)	0.00835 (0.00583)	0.00835 (0.00583)	0.312 (0.435)	0.264 (0.410)	0.264 (0.410)
First 6 gas _{it} (std)	-0.00378 (0.00461)	-0.00301 (0.00432)	-0.00301 (0.00432)	-0.0223 (0.329)	0.0160 (0.321)	0.0162 (0.321)
First 6 oil _{it} (std)	0.000430 (0.00382)	-0.0000654 (0.00295)	-0.0000245 (0.00295)	0.145 (0.300)	0.00243 (0.265)	0.00580 (0.265)
Observations	157,214	156,631	156,631	157,214	156,631	156,631
R-squared	0.58	0.66	0.66	0.59	0.66	0.66
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.319	0.319	0.319	27.429	27.429	27.429

Note: This panel reports the impact of PE ownership on pollution as a function of environmental risks. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Panel B: Stacked regressions

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.242*** (0.0493)			-19.55*** (4.976)		
Post buyout _{it} × liability risks		-0.00636*** (0.00111)			-0.507*** (0.129)	
Post buyout _{it} × High liability risks			-0.295*** (0.0510)			-22.42*** (6.153)
Vertical depth _{it} (std)	-0.0165 (0.0198)	-0.0165 (0.0198)	-0.0164 (0.0199)	-0.942 (0.953)	-0.936 (0.956)	-0.925 (0.964)
Horizontal length _{it} (std)	0.000192 (0.0229)	-0.000344 (0.0229)	-0.00214 (0.0229)	0.361 (1.332)	0.318 (1.330)	0.174 (1.342)
First 6 gas _{it} (std)	-0.00853 (0.0164)	-0.00837 (0.0164)	-0.00968 (0.0165)	0.134 (1.328)	0.112 (1.326)	0.00261 (1.333)
First 6 oil _{it} (std)	0.00823 (0.00759)	0.00833 (0.00762)	0.00919 (0.00769)	0.522 (0.608)	0.542 (0.611)	0.610 (0.612)
Observations	32,815	32,811	32,811	32,815	32,811	32,811
R-squared	0.75	0.75	0.75	0.77	0.77	0.77
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.421	0.421	0.421	32.731	32.731	32.731

Note: This panel reports the same specification as in the previous panel, except that the regressions are estimated on a stacked sample, following the approach of [Cengiz et al. \(2019\)](#). The goal of this approach is to avoid the bias caused by the staggered nature of PE acquisitions if the impact of PE buyout is non-homogeneous ([Baker, Larcker, and Wang \(2022\)](#)). The table reports the impact of PE ownership on pollution as a function of environmental risks on this stacked sample. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to mean a 0 of and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table 5: DrillCo Deals**A. Full Panel**

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post DrillCo _{it}	-0.0818** (0.0319)			-2.417 (2.554)		
Post DrillCo _{it} × Liability risk		-0.00115 (0.00115)			-0.0636 (0.103)	
Post DrillCo _{it} × High liability risk			-0.136* (0.0788)			-10.00 (7.678)
Vertical depth _{it} (std)	0.00260 (0.00426)	0.000285 (0.00389)	0.000286 (0.00391)	0.291 (0.299)	0.124 (0.284)	0.124 (0.285)
Horizontal length _{it} (std)	0.00932 (0.00587)	0.00834 (0.00582)	0.00834 (0.00582)	0.292 (0.433)	0.262 (0.409)	0.263 (0.409)
First 6 gas _{it} (std)	-0.00404 (0.00458)	-0.00307 (0.00432)	-0.00316 (0.00431)	-0.0291 (0.327)	0.0127 (0.321)	0.00485 (0.320)
First 6 oil _{it} (std)	0.0000925 (0.00379)	-0.0000915 (0.00294)	0.00000529 (0.00297)	0.134 (0.298)	0.00209 (0.264)	0.00799 (0.267)
Observations	157,214	156,631	156,631	157,214	156,631	156,631
R-squared	0.58	0.66	0.66	0.59	0.66	0.66
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.319	0.319	0.319	27.429	27.429	27.429

Note: This panel reports the impact of a PE DrillCo contract on pollution as a function of environmental risks. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Panel B: Stacked regressions

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post DrillCo _{it}	-0.0426 (0.0763)			-2.314 (6.101)		
Post DrillCo _{it} × Liability risk		-0.00137 (0.00244)			-0.0698 (0.198)	
Post DrillCo _{it} × High liability risk			0.143* (0.0807)			11.24 (8.922)
Vertical depth _{it} (std)	-0.00369 (0.00806)	-0.00391 (0.00819)	-0.00461 (0.00802)	-0.387 (0.605)	-0.396 (0.610)	-0.443 (0.604)
Horizontal length _{it} (std)	-0.00595 (0.0114)	-0.00609 (0.0116)	-0.00639 (0.0116)	-0.832 (0.956)	-0.837 (0.972)	-0.853 (0.960)
First 6 gas _{it} (std)	0.00359 (0.00748)	0.00443 (0.00732)	0.00613 (0.00663)	0.742 (0.581)	0.822 (0.581)	0.940* (0.563)
First 6 oil _{it} (std)	0.0157 (0.00953)	0.0153 (0.00947)	0.0152 (0.00928)	1.201 (0.733)	1.175 (0.730)	1.160 (0.732)
Observations	112,259	112,258	112,258	112,259	112,258	112,258
R-squared	0.66	0.67	0.67	0.67	0.67	0.67
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.296	0.296	0.296	26.336	26.336	26.336

Note: This panel reports the same specification as in the previous panel, except that the regressions are estimated on a stacked sample, following the approach of [Cengiz et al. \(2019\)](#). The goal of this approach is to avoid the bias caused by the staggered nature of DrillCo contracts if the impact of a DrillCo contract is non-homogeneous ([Baker, Larcker, and Wang \(2022\)](#)). The table reports the impact of a DrillCo contracts on pollution as a function of environmental risks on this stacked sample. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table 6: Natural Experiment

	Number of toxic chemicals _{it}		Number of toxic chemicals _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction		0.260*** (0.0891)		25.79*** (6.584)
BLM × PE-backed _{it} × 2017	0.499*** (0.0948)		43.83*** (10.14)	
Vertical depth _{it} (std)	0.00245 (0.00445)	0.00229 (0.00445)	0.376 (0.333)	0.361 (0.332)
Horizontal length _{it} (std)	0.0121 (0.00749)	0.0121 (0.00749)	0.433 (0.553)	0.432 (0.553)
First 6 gas _{it} (std)	-0.00117 (0.00356)	-0.00117 (0.00356)	0.212 (0.283)	0.211 (0.283)
First 6 oil _{it} (std)	-0.000260 (0.00352)	-0.000237 (0.00353)	0.00678 (0.324)	0.00628 (0.324)
Observations	161,011	161,011	161,011	161,011
R-squared	0.53	0.53	0.53	0.53
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	0.319	0.319	27.429	27.429

Note: The table reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on pollution for Native American reservations and federal lands for firms owned by a PE firm. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (day the State of California sued the BLM over the rescission). The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post Injunction and BLM × Post Buyout × 2017. They are both positive, which shows that PE-backed firms increase pollution following a reduction in litigation and compliance risks. The full interaction terms are added in the regressions. The dependent variable of columns (1), and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months’ production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table 7: Impact On Production**Panel A**

	6-month production _{it} (log)				Total production _{it} (log)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post buyout _{it}	0.315*** (0.102)	0.108** (0.0471)			0.192*** (0.0649)	0.00269 (0.0398)		
Post buyout _{it} × Liability risk			0.000167 (0.00126)				0.000555 (0.000380)	
Post buyout _{it} × High liability risk				-0.0430 (0.0578)				0.0242 (0.0175)
Vertical depth _{it} (std)		0.0474*** (0.0159)	0.0382*** (0.0147)	0.0382*** (0.0147)		0.0157** (0.00788)	0.0122 (0.00824)	0.0122 (0.00824)
Horizontal length _{it} (std)		0.474*** (0.0287)	0.445*** (0.0294)	0.445*** (0.0294)		0.439*** (0.00426)	0.415*** (0.00143)	0.415*** (0.00143)
Observations	144,723	139,186	138,629	138,629	158,130	152,297	151,735	151,735
R-squared	0.53	0.81	0.82	0.82	0.64	0.97	0.98	0.98
Firm FE _i	x	x			x	x		
Year FE _t	x				x			
Firm FE _i × year FE _t			x	x			x	x
State FE _i × year FE _t		x	x	x		x	x	x
Location _j × year FE _t		x	x	x		x	x	x
Mean Dep. Var.	10.562	10.562	10.562	10.562	12.367	12.367	12.367	12.367

Note: This panel investigates the impact of PE ownership on production. Log (6-month production_{it}) is defined as the first six months of oil and gas in BOE equivalent. This measure is a good proxy of production for the well, as can be seen in Figure 3. Log (Total Production_{it}) is the well's forecasted production using a standard Arps decline curve method. Columns (1) and (5) show that PE ownership is associated with an increase in production. However, columns (2) and (6) show that most of this increase in production is driven by technological change, as proxied by the horizontal and vertical size of the well, and changes in how projects are located, as captured by a location-year fixed effect. Columns (3), (4), (7), and (8) investigate whether the change in production among PE-firms varies across the environmental risk measures. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Panel B

	6-month production _{it} (log)		Total production _{it} (log)	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction	0.090 (0.116)		0.027 (0.028)	
BLM × PE-backed _{it} × 2007		0.042 (0.127)		-0.033** (0.016)
Vertical depth _{it} (std)	0.038*** (0.015)	0.038*** (0.015)	0.012 (0.008)	0.012 (0.008)
Horizontal length _{it} (std)	0.445*** (0.029)	0.446*** (0.029)	0.415*** (0.001)	0.415*** (0.001)
Observations	138,629	138,629	151,735	151,735
R-squared	0.82	0.82	0.98	0.98
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x		x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	10.562	10.562	12.367	12.367

Note: This panel replicates the baseline specification except that the dependent variables are production measures. The dependent variable of columns (1) and (2) is Log (6-month production_{it}). Log (6-month production_{it}) is defined as the first six months of oil and gas in BOE equivalent. This measure is a good proxy of production for the well, as can be seen in Figure 3. The dependent variable of columns (3) and (4) is Log (Total Production_{it}). Log (Total Production_{it}) is the well's forecasted production using a standard Arps decline curve method. The panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on the usage of confidential items for Native American reservations and federal lands for firms. The variable "Post injunction" takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day when the State of California sued the BLM over the rescission). The variable "2017" is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are: BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. The full interaction terms are added in the regressions. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table 8: Impact on Reporting Quality

Panel A

	Nb of confidential items _{it}			(Nb of confidential items _{it} > 0)		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.0490 (0.0301)			-0.0490 (0.0301)		
Post buyout _{it} × Liability risk		-0.000231 (0.000586)			-0.000231 (0.000586)	
Post buyout _{it} × High liability risk			-0.0264 (0.0287)			-0.0264 (0.0287)
Vertical depth _{it} (std)	0.00260 (0.00169)	0.00276* (0.00154)	0.00276* (0.00154)	0.00260 (0.00169)	0.00276* (0.00154)	0.00276* (0.00154)
Horizontal length _{it} (std)	0.00429* (0.00247)	0.00502** (0.00221)	0.00503** (0.00221)	0.00429* (0.00247)	0.00502** (0.00221)	0.00502** (0.00221)
First 6 gas _{it} (std)	-0.00160 (0.00108)	-0.00103 (0.00105)	-0.00103 (0.00105)	-0.00160 (0.00108)	-0.00103 (0.00105)	-0.00103 (0.00105)
First 6 oil _{it} (std)	0.000489 (0.00111)	0.00161* (0.000863)	0.00161* (0.000864)	0.000488 (0.00111)	0.00161* (0.000862)	0.00161* (0.000863)
Observations	157,214	156,631	156,631	157,214	156,631	156,631
R-squared	0.55	0.60	0.60	0.55	0.60	0.60
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.068	0.068	0.068	0.067	0.067	0.067

Note: This panel replicates the baseline specification except that the dependent variable is the number of confidential items. The dependent variable of columns (1), (2), and (3) is the number of confidential items reported per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value one if the well is using at least one confidential chemical and zero otherwise. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Panel B

	Nb of confidential items _{it}		(Nb of confidential items _{it} > 0)	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction	0.056** (0.027)		0.052** (0.026)	
BLM × PE-backed _{it} × 2007		0.040 (0.025)		0.040 (0.025)
Vertical depth _{it} (std)	0.003* (0.002)	0.003* (0.002)	0.001 (0.001)	0.003* (0.002)
Horizontal length _{it} (std)	0.005** (0.002)	0.005** (0.002)	0.004* (0.002)	0.005** (0.002)
First 6 gas _{it} (std)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
First 6 oil _{it} (std)	0.002* (0.001)	0.002* (0.001)	0.002** (0.001)	0.002* (0.001)
Observations	156,631	156,631	159,074	156,631
R-squared	0.60	0.60	0.60	0.60
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x		x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	0.068	0.068	0.067	0.067

Note: This panel replicates the baseline specification except that the dependent variable is the number of confidential items. The dependent variable of columns (1) and (2) is the number of confidential items reported per well. The dependent variable of columns (3) and (4) is a dummy that takes the value one if the well is using at least one confidential chemical and zero otherwise. The panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on the usage of confidential items for Native American reservations and federal lands for PE-backed firms. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day when the State of California sued the BLM over the rescission). The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. The full interaction terms are added in the regressions. The controls include the size (horizontal length and vertical depth) and production (6 first months’ production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

ONLINE APPENDIX

This Internet Appendix presents the following additional analyses, additional institutional background, and robustness tests:

- **Highlight 1:** Quote and citations from the main PE sponsors in the oil and gas industry
- **Highlight 2:** Additional legal background on the fracking rule
- **Highlight 3:** Discussion of theoretical models that could explain the results
- **Figure A.1:** Relationship between Pollution and Production
- **Figure A.2:** Relationship between Pollution, Financial Constraints, and Production: replicates the positive relationships between financial distress and pollution, as well as financial constraints and pollution.
- **Figure A.3** Pre-Trend around a PE Buyout: Overall Effect: investigate whether a pre-trend drives the results
- **Figure A.4:** Pre-Trend around a PE Buyout: Liability Risk: investigate whether a pre-trend drives the results
- **Figure A.5:** Event Study around a PE DrillCo: Overall Effect: shows the direct effect of a DrillCo deal
- **Figure A.6:** Event Study around a PE DrillCo: Liability Risk: shows the effect of a DrillCo deal as a function of environmental liability risk
- **Figure A.7:** Pre-Trend around a PE DrillCo: Overall Effect: investigates whether a pre-trend drives the results
- **Figure A.8:** Pre-Trend around a PE DrillCo: Liability Risk: investigates whether a pre-trend drives the results
- **Table A.1:** Balance Test: Liability Risk: shows the balance tests according to environmental liability risk measures
- **Table A.2:** Balance Test: DrillCo: shows the balance tests between the DrillCo target and the other firms
- **Table A.3:** Baseline Effects Assuming that Confidential Items are Toxic: replicates the baseline specifications by assuming that all confidential items are toxic chemicals
- **Table A.4:** Robustness Tests: Controlling for Disclosure Practices: adds a confidential item times year fixed effects to the baseline specifications
- **Table A.5:** Controlling for Nonlinear Effects of Production: adds the production controls and their squared values to the baseline specifications

- **Table A.6:** Other Measures of Toxic Chemical: EPA EHS List: replicates the baseline specifications by using a first alternative definition of toxic chemical: EPA extremely hazardous substance list
- **Table A.7:** Other Measures of Toxic Chemical: EPA IRIS Database: replicates the baseline specifications by using a second alternative definition of toxic chemical: the EPA IRIS database
- **Table A.8:** Poisson Regression: estimates the baseline specifications using a Poisson regression
- **Table A.9:** Natural Experiment Using Only Federal Land: replicates the natural experiment by focusing on federal lands
- **Table A.10:** Alternative Proxy for Environmental Risk: PE Buyout: replicates the baseline specifications for PE buyouts using an alternative proxy for environmental liability risks
- **Table A.11:** Alternative Proxy for Environmental Risk: PE DrillCo: replicates the baseline specifications for PE DrillCos using an alternative proxy for environmental liability risk
- **Table A.12:** Baseline Specification: Double Clustering: estimates the baseline specifications where the standard errors are two-way clustered at the firm and location level
- **Table A.13:** Common Trend Assumption: Statistics: reports different statistics to evaluate whether a linear pre-trend with a power of 80% drives the baseline results.
- **Table A.14:** Robustness of a pre-trend violation: smoothness restrictions: reports a sensitivity analysis based on smoothness restrictions, following [Rambachan and Roth \(2023\)](#)

Highlight 1: Quote And Citations From the Main PE Sponsors in the Oil and Gas Industry

"The broad set of sustainability issues (including social and governance issues) have material influence on TPG's assessments of risk, valuation, profitability, and opportunity, across the portfolio" **TPG Capital** (2019 ANNUAL GES REPORT)

"Saving water helps to preserve our environment as it is limited resource on earth and it will help to ensure a sustainable adequate water supply in future." **Riverstone Holdings** (Sustainability Report, 2017)

"Contributed to national environmental standards formulation process through collaboration with the US Department of Energy to improve shale gas production best practices, disclosure and technology." **First Reserve Corporation**^a

"We encourage and embrace the efficient use of natural resources and continuously look for and expect the best environmental solutions for our portfolio companies' operations. We believe that economic considerations in isolation do not provide sufficient guidance for environmentally conscious decision-making that balances the interests of individuals, communities and future generations. We seek to fully comply and/or exceed compliance with applicable environmental regulatory requirements." . "Promote the importance to our operators of being responsible stewards of air, land, and water." **EnCap Investments**^b

"We recognize the importance of climate change, biodiversity, and human rights, and believe negative impacts on project-affected ecosystems, communities, and the climate should be avoided." **Denham Capital Management**^c

"As we outlined in our 2010 Corporate Citizenship Report, our overall responsible investing priorities continue to be: [...] Mitigate the potential negative effects of low-probability, high-impact ESG risks." **Carlyle Group** (Corporate Citizenship 2011)

"Protecting the environment of the communities in which we operate is critically important." **Blackstone Group**^d

^aSource: <https://www.firstreserve.com/investment-strategy/esg-and-pri-in-energy>

^bSource: <https://www.efmidstream.com/esg> and <https://www.encapinvestments.com/esg>

^cSource: <https://www.denhamcapital.com/about/>

^dSource: <http://www.blackstone.com/citizenship/social-environmental-sustainability>

Highlight 2: Additional Background to the Fracking Rule

The Bureau of Land Management (BLM) is responsible for the environmental regulation of federal land and Native American reservations. As a federal agency within the US Department of the Interior, it oversees one-eighth of the land in the continental United States. Its core mission is “to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.” Within its mission, the BLM supervises the leasing of oil and gas reserves and provides technical advice for drilling operations on Native American reservations.

In 2012, the BLM started drafting a regulation to reduce the negative externalities caused by hydraulic fracturing. After collecting feedback, remarks, and comments, the rule was finalized and made available on March 26, 2015. The regulation was supposed to be effective as of June 24, 2015. It comprised several mandates: (1) improve the disclosure of operational activities, (2) increase the quality and integrity of the wellbore, and (3) increase the standard of water protection. This rule did not forbid the usage of highly toxic chemicals but increased their indirect costs. Specifically, operators were required to “isolate all usable water and other mineral-bearing formations and protect them from contamination.”^a The “Oil and Gas; Hydraulic Fracturing on Federal and Indian Lands” (2015 rule) expanded the definition of usable water to include “waters containing up to 10,000 parts per million (ppm) of total dissolved solids,” which doubled the previous threshold.

On March 20, 2015, various petitioners filed a motion for a preliminary injunction^b to challenge the fracking rule.^c The preliminary injunction was granted by the Federal Court of the Tenth Circuit. The court found that “BLM did not have the authority to regulate fracking” (Williams (2015)), ending uncertainty over whether the BLM had legislative power over fracking activities. Specifically, each of the acts used by the BLM to justify its right to enact the 2015 rule, such as the Federal Land Policy and Management Act (“FLPMA”) and the Mineral Leasing Act (“MLA”), was rejected by the court, under the reasoning that “none of them gave BLM authority to regulate fracking” (Williams (2015)).^d

On June 21, 2016, the rule was abrogated by the District of Wyoming. Three days later, the BLM appealed. On January 20, 2017, Trump was inaugurated and proceeded to change the political orientation of the BLM, which now no longer supports the fracking rule. An Interior Department Assistant Secretary stated that an “initial review has revealed that the 2015 Rule does not reflect . . . the current Administration’s policies and priorities concerning the regulation of hydraulic fracturing on Federal and Indian lands.”^e Shortly after, the Trump administration issued an executive order asking the BLM to rescind the rule.^f This caused the Tenth Circuit to dismiss the lawsuit as moot on September 21, 2017. The rescission was made official on December 29, 2017.

^a“Oil and Gas; Hydraulic Fracturing on Federal and Indian Lands” (2015 rule), Federal Register.

^bA preliminary injunction is a temporary decision that preserves the status quo until the courts decide on the case.

^cThe petitioners included the Independent Petroleum Association of America (IPAA); the Western Energy Alliance (Alliance); the states of Colorado, North Dakota, Utah, and Wyoming; and the Ute Indian Tribe.

^dThe remaining reasons to grant the preliminary injunction were the following. First, the regulation was not supported by “substantial evidence and lacked rational justification.” Second, consultations with indigenous American tribes were not made in a way consistent with procedures and policies that this regulatory authority should respect. The next two reasons stated that the petitioners would have incurred “irreparable harm” if the regulation was allowed while litigation was pending and these costs outweighed any potential harm to the BLM.

^eSource: California v. U.S. Bureau of Land Management (Case: 20-16157, 10/21/2020, ID: 11867759)

Following this rescission, the state of California and a group of environmental activists sued the BLM on January 24, 2018, for voiding the fracking rule. Three main reasons were put forward to justify such an action. First, the plaintiffs accused the BLM of being capricious, citing the Administrative Procedure Act (APA). This Act requires that any agency supplement a policy change with an explanation of improvements brought about by that change. The rescission was supposed to promote energy development on federal and tribal lands by removing regulatory burdens. However, this explanation was not supported by the evidence put forward by the BLM, which found that the price of oil and gas was the main factor affecting the production of fracking activities. The plaintiffs therefore claimed that the BLM's explanation "runs counter to the evidence before the agency." Secondly, the APA requires that agencies should always act in a way allowed by their statute. The rescission of the fracking rule was seen as contradicting the BLM's statute. Indeed, the core missions of the BLM are to prevent "unnecessary or undue degradation" of public lands and to enable the development of energy while ensuring environmental protections. Third, the decision to rescind the rule violated the National Environmental Policy Act because the BLM did not conduct an environmental impact analysis of the repeal.

Highlight 3: Discussion Of Theoretical Models That Could Explain The Results (1/2)

Providing a micro foundation for why PE-backed firms develop operating expertise, as stated in [Gompers, Kaplan, and Mukharlyamov \(2016\)](#), is outside the scope of this paper. To the best of my knowledge, no theory explicitly models firms' heterogeneity in their operating expertise as a function of their ownership structures. That said, this subsection discusses potential reasons based on existing theories.

To summarize, there are two comparison groups: private firms and publicly listed firms. The difference in pollution outcomes between PE-backed firms and private firms can be explained by theories of sorting based on skills and capital ([Evans and Jovanovic \(1989\)](#)). The difference between publicly listed firms and PE-backed firms can be explained by rational short-termism ([Stein \(1989\)](#)). Indeed, publicly listed firms have the operational expertise to implement good environmental practices. However, they do not implement these practices fully because they face short-term pressures and increase pollution to maximize short-term earnings at the expense of long-term earnings, as supported by ample empirical evidence ([Gao, Kim, and Xu \(2018\)](#); [Thomas et al. \(2022\)](#)). I detail the explanation below.

In the model of [Evans and Jovanovic \(1989\)](#), people sort into entrepreneurial or salaried work based on two parameters: their skills to be an entrepreneur and wealth endowments. People endowed with more capital or more skills create larger firms. Capital constraints limit the amount of investment a company can make. While the model has only one input, namely capital, it could be straightforward to add other inputs to the production function, such as highly talented labor that provides operational expertise. Such highly productive employees could be people with advanced degrees or ample industry expertise. As a result, firms that do not face the wealth constraint can hire such workers.

It is a reasonable assumption to think that PE-backed firms face lower financial constraints than private non-PE-backed firms. PE firms have access to committed capital, which is capital that the general partner can request from a limited partner. The sponsor can inject equity directly into the target company if need be, as shown by [Bernstein, Lerner, and Mezzanotti \(2019\)](#). Moreover, private sponsors have more pledgeable income because they can borrow against their reputational capital ([Malenko and Malenko \(2015\)](#)). This means that banks are more willing to lend to private equity firms because they know that the PE sponsor has a strong incentive to repay the debt for a given deal, because otherwise the PE sponsor will not be able to raise debt for the next deal.

This sorting explanation is consistent with the non-result for the DrillCo outcomes. The DrillCo deal does not finance the recruitment of highly skilled workers at the firm or PE sponsor level but a specific and well-defined set of projects. In some sense, it reduces the cost of buying capital without changing the company's other production inputs, such as skilled labor.

While this explanation might rationalize why the pollution behaviors of PE-backed firms differ from the non-buyout privately held companies, this theoretical explanation alone fails to explain why the behaviors of PE-backed firms would differ from publicly listed firms. This indicates that other concomitant frictions are at play. PE-backed firms and publicly listed firms differ fundamentally in the amount of asymmetric information they have between the owners of the firms and the managers. As a result, publicly listed firms face short-termism constraints that do not face PE-backed firms.

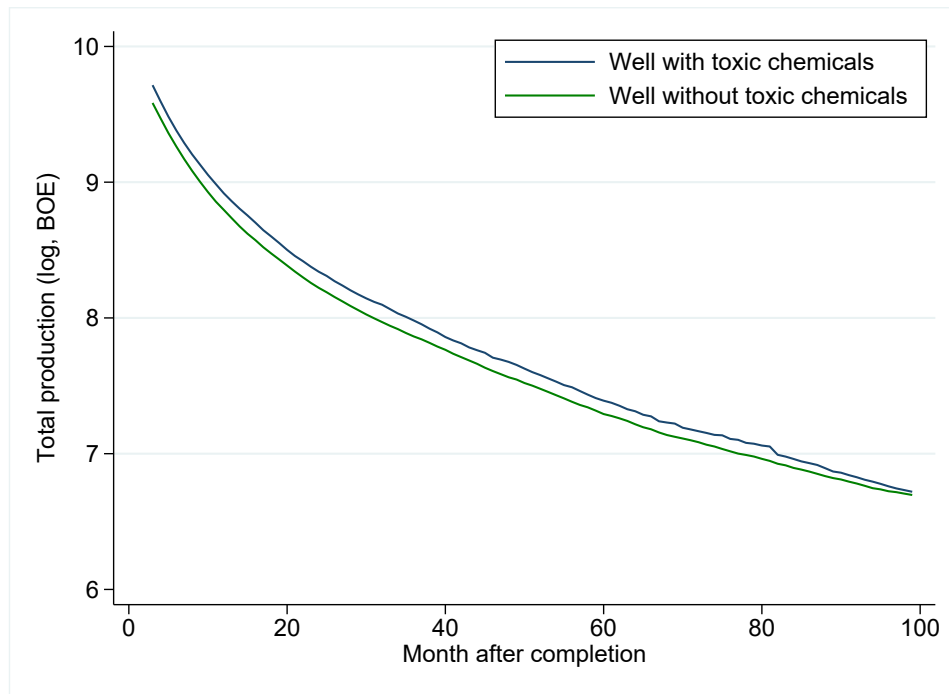
Highlight 3: Discussion Of Theoretical Models That Could Explain The Results (2/2)

Asymmetric information and the separation of ownership and control could explain why public firms do not react as strongly to changes in environmental liabilities. Public company managers are incentivized to provide short-term signals of high profit at the cost of long-term profit, even with a rational stock market (Stein (1989)). Indeed, the stock market uses earnings to make forecasts about a firm's fundamental value. Knowing this, managers have an incentive to boost earnings, even if this can come at the expense of long-term value. However, the stock market anticipates this incentive of the managers to boost short-term earnings. As a result, the stock market adjusts short-term earnings with an inflation factor. However, this anticipation incentivizes managers to boost short-term earnings even more. One way to boost short-term earnings at the expense of long-term earnings is to pollute more, even if the future liability cost of polluting is high. Consistent with this fact, Gao, Kim, and Xu (2018) and Thomas et al. (2022) find a strong empirical link between short-term pressure, as captured by analysts' forecasts, and pollution practices.

Private equity firms are less exposed to these short-termism pressures. Public-listed firms' owners are generally dispersed, increasing the incentive to free-ride the monitoring and making the implementation of disciplinary actions more difficult to coordinate. In contrast, private equity firms fully own the company in a buyout. Moreover, the capital committed to a private equity sponsor is more illiquid than stocks in the public equity market. Once the general partners call the limited partners' capital, this committed capital will generate its payoffs once the fund exits and distributes the proceeds. The illiquidity of the committed capital means that the general partners face less incentive to generate quarterly signals of performance and can focus on the exit value of the portfolio company. This contrasts with the publicly listed firms' managers, who face pressure not to miss their quarterly or yearly earnings targets set by their analysts (Terry (2023)).

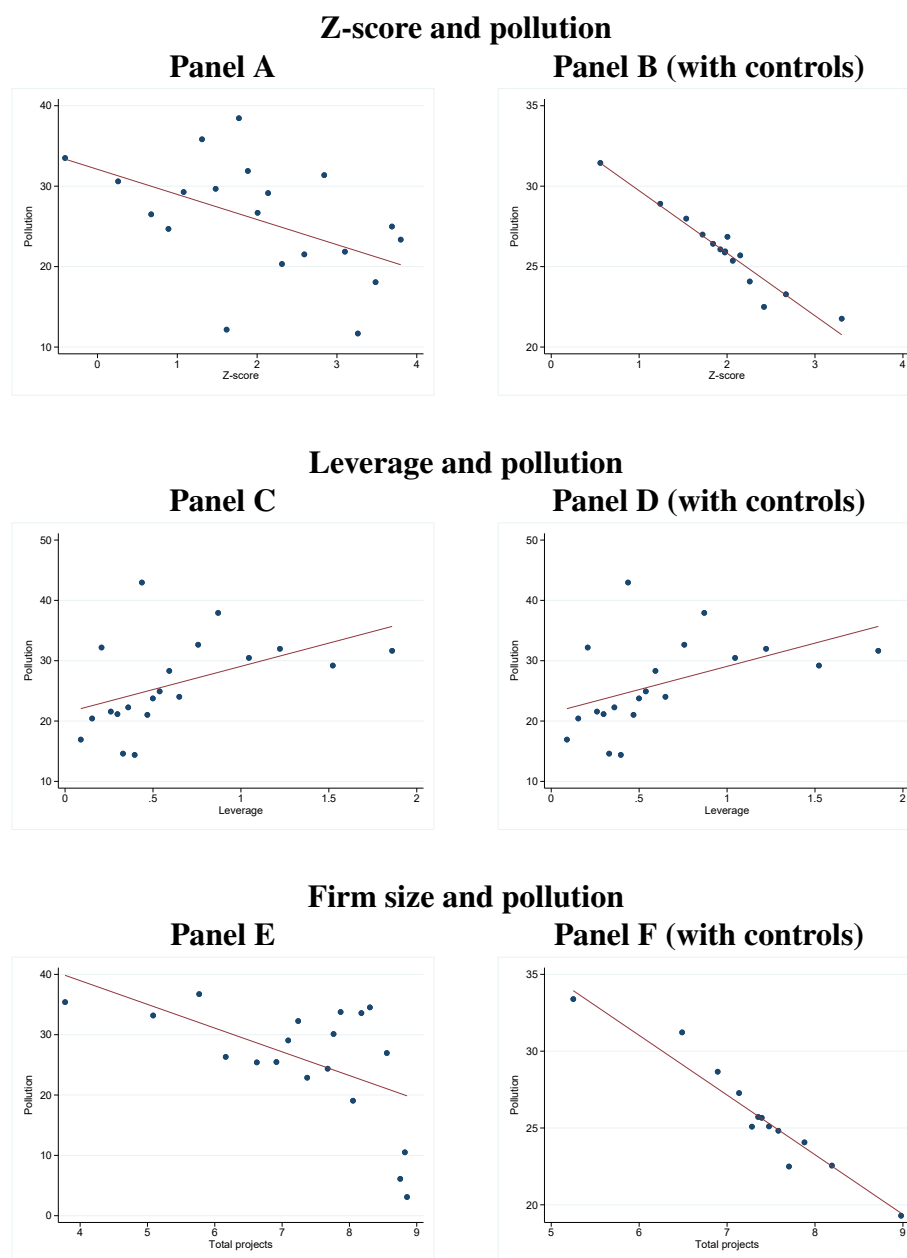
To conclude, the fact that PE firms develop operating expertise that makes corporate pollution consistent with shareholder value maximization can be rationalized by their institutional features. First, PE firms ease capital access and, thus, the acquisition of high-skilled workers. Second, they closely monitor the portfolio company that they entirely own in a buyout. This reduces asymmetric information between the owner and the managers, and solves potential coordination problems between owners, which are the source of short-termism pressures that can lead to additional pollution.

Figure A.1: Relationship between Pollution and Production



Note: This graph shows the monthly production in log, in BOE equivalent, of wells that have at least one chemical and wells that do not use a toxic chemical. As observed, the wells that use a toxic chemical produce more than those that do not. While the relationship is not causal, it is consistent with the view that more pollution is associated with increased production (Shapiro and Walker (2018)). Intuitively, wells built using a smaller set of inputs produce a volume of hydrocarbons lower than or at least equal to those made using an unconstrained set of inputs.

Figure A.2: Relationship between Pollution, Financial Constraints, and Production

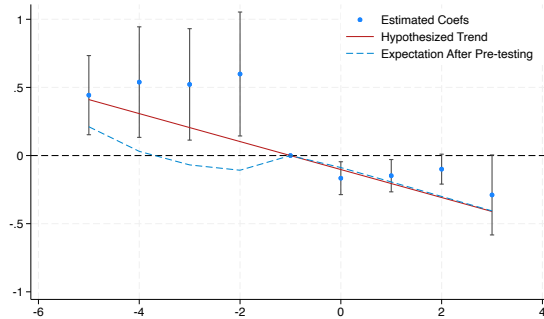


Note: The goal of these panels is to replicate the well-known relationship between financial constraints/distress and pollution. Firms closer to filing for bankruptcy are more likely to pollute. They are riskier and, therefore, face a higher cost of capital, which reduces their investment in abatement projects. Moreover, firms close to bankruptcy are more likely to pollute due to a risk-shifting effect: they reap the full benefit of polluting, but part of their expected costs is discharged through bankruptcy. The argument that firms more financially constrained or close to bankruptcy are more likely to pollute has received extensive empirical support (Cohn and Deryugina (2018), De Haas and Popov (2019), Levine et al. (2019), Xu and Kim (2022), Ohlrogge (2023), and Bellon and Boualam (2024)).

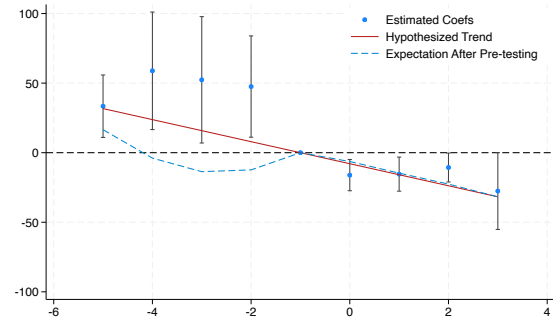
Panel A reports the relationship between the Altman Z-score and pollution. Panel B reports the same relationship, after controlling for location-year fixed effects. Panel C reports the relationship between leverage and pollution. Panel D reports the relationship between leverage and pollution, once location-year fixed effects are included. Finally, panel E shows the relationship between firm size and pollution, while panel F plots the same relationship, once location-year fixed effects are included. I proxy for firms' size by computing the total number of projects drilled in the whole sample for each firm.

Figure A.3: Pre-Trend around a PE Buyout: Overall Effect

Panel A: Number of toxic chemicals_{it}



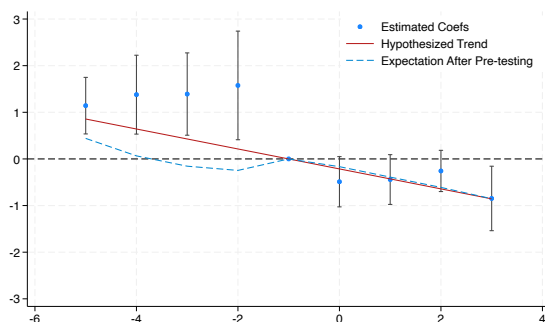
Panel B: Number of toxic chemicals_{it} > 0



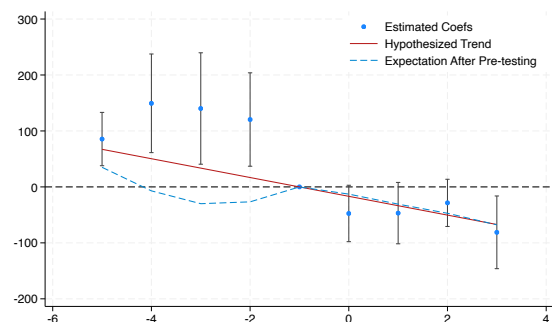
Note: The goal of these figures is to investigate whether a pre-trend drives the results. To that end, this graph replicates the dynamic event study of Figure 5 and displays the hypothesized trend and the Expectation After Pre-testing. The hypothesized trend is the linear pre-trend with a power threshold of 80%. I choose 80% following Roth (2022), since it is often used as a benchmark for the minimum detectable effect in power analyses (Cohen (2013)). The expectation after pre-testing tells us what the coefficients should look like conditional on not finding a significant pre-trend if the true pre-trend was the hypothesized trend. These coefficients are almost always outside the pre-period confidence intervals, bringing more confidence to the idea that a pre-trend is not driving the results.

Figure A.4: Pre-Trend around a PE Buyout: Liability Risk

Panel A: Number of toxic chemicals_{it}

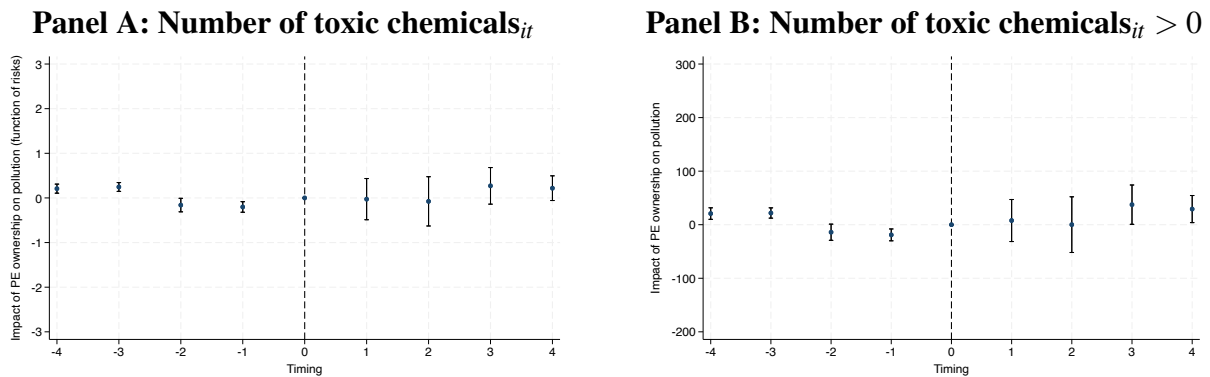


Panel B: Number of toxic chemicals_{it} > 0



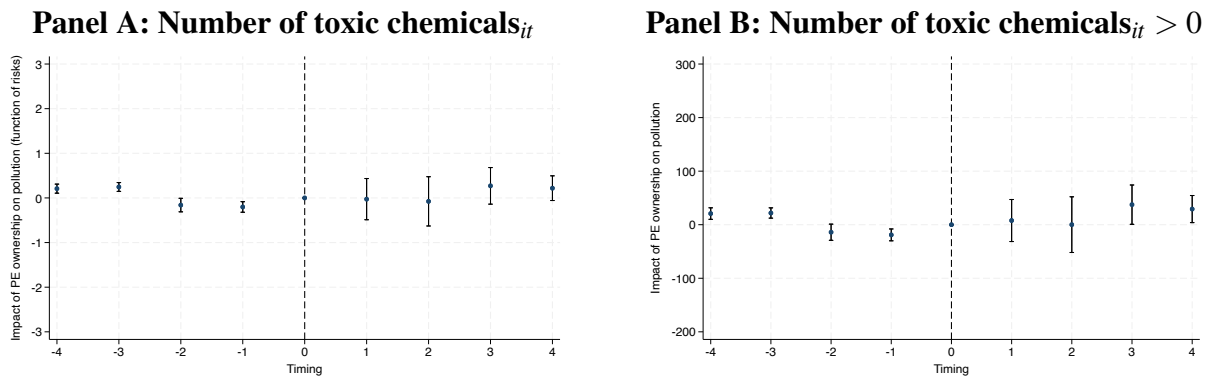
Note: The goal of these figures is to investigate whether a pre-trend drives the results. To that end, this graph replicates the dynamic event study of Figure 6 and displays the hypothesized trend and the Expectation After Pre-testing. The hypothesized trend is the linear pre-trend with a power threshold of 80%. I choose 80% following Roth (2022), since it is often used as a benchmark for the minimum detectable effect in power analyses (Cohen (2013)). The expectation after pre-testing tells us what the coefficients should look like conditional on not finding a significant pre-trend if the true pre-trend was the hypothesized trend. These coefficients are always outside the pre-period confidence intervals, bringing more confidence to the idea that a pre-trend is not driving the results.

Figure A.5: Event Study around a PE DrillCo: Overall Effect



Note: Panels A and B show the dynamic graph of the average pollution around a PE DrillCo in the difference-in-differences specifications. The specifications are estimated in the stacked panel, following the approach of [Cengiz et al. \(2019\)](#). I replicate the difference-in-differences specifications wherein the main coefficient of interest is estimated through different time dummies. Specifically, both panels plot the event-study of the net effect of PE DrillCo on pollution, in a difference-in-differences specification, that includes a firm, state-year, and location fixed effects, and production and technology controls. These fixed effects are interacted with a cohort fixed effect. The dependent variable of the specification in Panel B is “Number of toxic chemicals_{it}”, the number of toxic chemicals used by the firm. Panel A shows the results of the same specification, except that the dependent variable is “Number of toxic chemicals_{it} > 0”, a dummy that takes the value 100 if the firm uses at least one toxic chemical and zero otherwise.

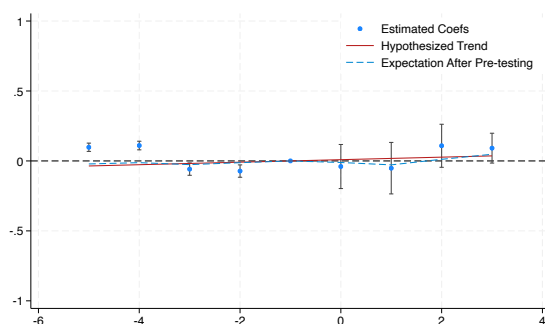
Figure A.6: Event Study around a PE DrillCo: Liability Risk



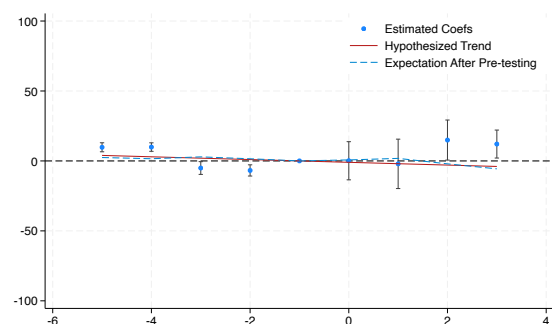
Note: These panels show the dynamic graph of the average pollution around a PE DrillCo in difference-in-differences specifications as a function of liability risk. The specifications are estimated in the stacked panel, following the approach of Cengiz et al. (2019). I replicate the difference-in-differences specifications wherein the main coefficient of interest is estimated through different time dummies. Specifically, both panels show the impact of PE DrillCo as a function of environmental liability risk. Technology and production controls are included, and firm-year, state-year and location fixed effects are added in all specifications. These fixed effects are interacted with a cohort fixed effect. The dependent variable of Panel A is “Number of toxic chemicals_{it}”, the number of toxic chemicals used by the firm. The dependent variable of Panel B is “Number of toxic chemicals_{it} > 0”, a dummy that takes the value 100 if the firm uses at least one toxic chemical and zero otherwise.

Figure A.7: Pre-Trend around a PE DrillCo: Overall Effect

Panel A: Number of toxic chemicals_{it}



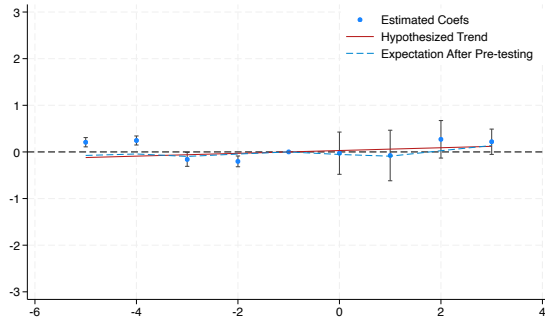
Panel B: Number of toxic chemicals_{it} > 0



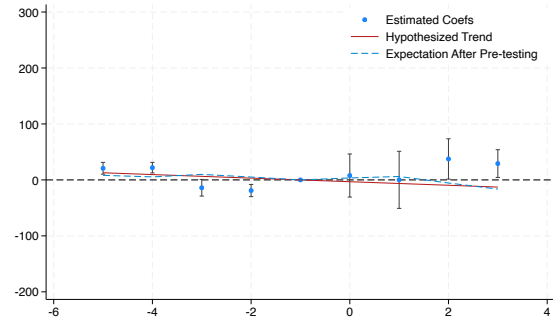
Note: The goal of these figures is to investigate whether a pre-trend drives the results. To that end, this graph replicates the dynamic event study of Figure A.5 and displays the hypothesized trend and the Expectation After Pre-testing. The hypothesized trend is the linear pre-trend with a power threshold of 80%. I choose 80% following Roth (2022), since it is often used as a benchmark for the minimum detectable effect in power analyses (Cohen (2013)). The expectation after pre-testing tells us what the coefficients should look like conditional on not finding a significant pre-trend if the true pre-trend was the hypothesized trend. These coefficients are almost always outside the pre-period confidence intervals, bringing more confidence to the idea that a pre-trend is not driving the results.

Figure A.8: Pre-Trend around a PE DrillCo: Liability Risk

Panel A: Number of toxic chemicals_{it}



Panel B: Number of toxic chemicals_{it} > 0



Note: The goal of these figures is to investigate whether a pre-trend drives the results. To that end, this graph replicates the dynamic event study of Figure A.6 and displays the hypothesized trend and the Expectation After Pre-testing. The hypothesized trend is the linear pre-trend with a power threshold of 80%. I choose 80% following Roth (2022), since it is often used as a benchmark for the minimum detectable effect in power analyses (Cohen (2013)). The expectation after pre-testing tells us what the coefficients should look like conditional on not finding a significant pre-trend if the true pre-trend was the hypothesized trend. These coefficients are almost always outside the pre-period confidence intervals, bringing more confidence to the idea that a pre-trend is not driving the results.

Table A.1: Balance Test: Liability risk

A. Liability Risks

	High liability risks	Low liability risks	Diff.	S.D.
Number of toxic chemicals _{it}	0.31	0.33	-0.02	0.02
Number of toxic chemicals _{it} > 0	25.94	29.65	-3.706*	2.03
PE buyout targets	0.04	0.05	-0.02	0.01
PE DrillCo targets	0.11	0.11	0.00	0.02
Months to Production	6.45	11.11	-4.655***	0.62
Vertical depth	8,230.14	8,506.60	-276.50	272.80
Horizontal length	4,035.33	6,471.57	-2436.2***	372.00
First 6 gas	231,467.14	259,295.25	-27,828.10	27,986.10
First 6 oil	27,486.80	44,190.29	-16703.5***	2,758.90
Nb of confidential items _{it} > 0	0.08	0.06	0.02	0.01
Nb of confidential items _{it}	0.08	0.06	0.02	0.01

B. Enforcement Risks

	High enforcement	Low enforcement	Diff.	S.D.
Number of toxic chemicals _{it}	0.25	0.4	-0.151***	0.0233
Number of toxic chemicals _{it} > 0	21.52	34.2	-12.68***	1.843
PE buyout targets	0.04	0.03	0.0056	0.0122
PE DrillCo targets	0.12	0.1	0.0245	0.0483
Months to Production	6.21	10.75	-4.541***	0.63
Vertical depth	8445.88	8221.15	224.7	193.8
Horizontal length	4130.23	6027.64	-1897.4***	235.1
First 6 gas	184416.31	309429.89	-125013.6***	24816.5
First 6 oil	28421.7	40820.58	-12398.9***	2722.1
Nb of confidential items _{it} > 0	0.09	0.05	0.0409***	0.0127
Nb of confidential items _{it}	0.09	0.05	0.0409***	0.0127

Note: This table reports the balance statistics, according to the environmental liability risk measure (Panel A) or the enforcement risk measure (Panel B). Standard errors are clustered at the firm level.

Table A.2: Balance Test: DrillCo

	Target DrillCo	Non-Target of DrillCo	Diff.	S.D.
Number of toxic chemicals _{it}	0.290	0.320	-0.035	0.047
Number of toxic chemicals _{it} > 0	25.320	27.590	-2.263	3.779
Months to Production	8.050	8.330	-0.271	1.394
Vertical depth	8,625.420	8,310.580	314.800	318.600
Horizontal length	5,099.710	4970.86	128.900	463.300
First 6 gas	207,986.310	247,073.880	-39,087.600	45,017.800
First 6 oil	34,628.070	34,115.150	512.900	5,746.800
Nb of confidential items _{it} > 0	0.030	0.070	-0.0383**	0.018
Nb of confidential items _{it}	0.030	0.070	-0.0383**	0.018

Note: This table shows the difference in characteristics between companies that signed a DrillCo contract in the sample and those that did not. Standard errors are clustered at the firm level.

Table A.3: Baseline Effects Assuming that Confidential Items are Toxic

Panel A:

	Number of toxic chemicals+confidential items _{it}			Number of toxic chemicals+confidential items _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.186*** (0.0504)			-22.27*** (3.606)		
Post buyout _{it} × Liability risk		-0.00531*** (0.00110)			-0.435*** (0.0977)	
Post buyout _{it} × High liability risk			-0.260*** (0.0409)			-19.30*** (4.264)
Vertical depth _{it} (std)	0.00302 (0.00378)	0.00301 (0.00378)	0.00297 (0.00379)	0.480* (0.290)	0.328 (0.268)	0.325 (0.268)
Horizontal length _{it} (std)	0.0134** (0.00546)	0.0134** (0.00546)	0.0134** (0.00546)	0.708* (0.406)	0.726* (0.379)	0.725* (0.379)
First 6 gas _{it} (std)	-0.00404 (0.00429)	-0.00404 (0.00429)	-0.00404 (0.00429)	-0.156 (0.329)	-0.0752 (0.322)	-0.0750 (0.322)
First 6 oil _{it} (std)	0.00154 (0.00301)	0.00155 (0.00301)	0.00159 (0.00301)	0.210 (0.323)	0.173 (0.281)	0.176 (0.280)
Observations	156,631	156,631	156,631	157,214	156,631	156,631
R-squared	0.65	0.65	0.65	0.59	0.65	0.65
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.387	0.387	0.387	33.665	33.665	33.665

Note: This panel replicates the baseline specification, but by making the strong assumption that all confidential items are toxic chemicals. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals plus the number of confidential items used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical or reports at least one confidential item and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Panel B

	Number of toxic chemicals+confidential items _{it}		Number of toxic chemicals+confidential items _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction	0.309*** (0.105)		31.899*** (7.635)	
BLM × PE-backed _{it} × 2007		0.594*** (0.107)		52.734*** (9.681)
Vertical depth _{it} (std)	0.003 (0.004)	0.003 (0.004)	0.303 (0.266)	0.324 (0.268)
Horizontal length _{it} (std)	0.013** (0.005)	0.013** (0.005)	0.703* (0.378)	0.701* (0.377)
First 6 gas _{it} (std)	-0.004 (0.004)	-0.004 (0.004)	-0.061 (0.323)	-0.064 (0.323)
First 6 oil _{it} (std)	0.002 (0.003)	0.002 (0.003)	0.181 (0.284)	0.173 (0.282)
Observations	156,631	156,631	156,631	156,631
R-squared	0.65	0.65	0.65	0.65
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	0.387	0.387	33.665	33.665

Note: This panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on pollution for Native American reservations and federal lands for PE-backed firms. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day the State of California sued the BLM over the rescission). The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. They are both positive, which shows that PE-backed firms increase pollution following a reduction in litigation and compliance risks. The full interaction terms are added in the regressions. The dependent variable of columns (1), and (2) is the number of toxic chemicals plus the number of confidential items used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical or reports at least one confidential items, and zero otherwise. The list of toxic chemicals can be found in Table 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.4: Robustness Tests: Controlling for Disclosure Practices

Panel A

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.258*** (0.0757)			-18.05*** (4.735)		
Post buyout _{it} × Liability risk		-0.00522*** (0.00115)			-0.431*** (0.0926)	
Post buyout _{it} × High liability risk			-0.242*** (0.0405)			-19.63*** (3.780)
Vertical depth _{it} (std)	0.00329 (0.00419)	0.000885 (0.00379)	0.000844 (0.00380)	0.352 (0.289)	0.174 (0.272)	0.171 (0.272)
Horizontal length _{it} (std)	0.0106* (0.00570)	0.00957* (0.00566)	0.00956* (0.00566)	0.406 (0.417)	0.368 (0.393)	0.367 (0.392)
First 6 gas _{it} (std)	-0.00415 (0.00458)	-0.00331 (0.00429)	-0.00330 (0.00429)	-0.0541 (0.326)	-0.00902 (0.319)	-0.00881 (0.319)
First 6 oil _{it} (std)	0.000638 (0.00380)	0.000389 (0.00297)	0.000431 (0.00297)	0.162 (0.302)	0.0416 (0.268)	0.0451 (0.268)
Observations	157,214	156,631	156,631	157,214	156,631	156,631
R-squared	0.59	0.67	0.67	0.60	0.67	0.67
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
(Nb of confidential items _{it} > 0) × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.319	0.319	0.319	27.429	27.429	27.429

Note: This panel reports the impact of PE ownership on pollution as a function of environmental risks, but includes the interaction of a year fixed effect and a dummy variable that takes the value one if the well is reporting at least one confidential item and zero otherwise. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Panel B

	Number of toxic chemicals _{it}		Number of toxic chemicals _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction		0.265*** (0.102)		27.77*** (7.404)
BLM × PE-backed _{it} × 2017	0.561*** (0.104)		49.88*** (9.372)	
Vertical depth _{it} (std)	0.000921 (0.00379)	0.000710 (0.00377)	0.178 (0.272)	0.158 (0.270)
Horizontal length _{it} (std)	0.00940* (0.00565)	0.00941* (0.00566)	0.355 (0.392)	0.355 (0.392)
First 6 gas _{it} (std)	-0.00323 (0.00430)	-0.00322 (0.00430)	-0.00392 (0.319)	-0.00465 (0.319)
First 6 oil _{it} (std)	0.000406 (0.00297)	0.000459 (0.00299)	0.0436 (0.269)	0.0456 (0.269)
Observations	156,631	156,631	156,631	156,631
R-squared	0.67	0.67	0.67	0.67
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
(Nb of confidential items _{it} > 0) × year FE _t	x	x	x	x
Mean Dep. Var.	0.319	0.319	27.429	27.429

Note: This panel replicates the baseline specification, but includes the interaction of a year fixed effect and a dummy variable that takes the value one if the well is reporting at least one confidential item and zero otherwise. The dependent variable of columns (1) and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on the usage of confidential items for Native American reservations and federal lands for PE-backed firms. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day the State of California sued the BLM over the rescission) and zero otherwise. The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. The full interaction terms are added in the regressions. The controls include the size (horizontal length and vertical depth) and production (6 first months’ production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.5: Controlling for Nonlinear Effects of Production

A. Baseline effects

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.212*** (0.0364)			-21.10*** (4.451)		
Post buyout _{it} × Liability risk		-0.00556*** (0.000822)			-0.429*** (0.0903)	
Post buyout _{it} × High liability risk			-0.240*** (0.0348)			-18.76*** (4.066)
Vertical depth _{it} (std)	-0.00441 (0.00453)	-0.00443 (0.00453)	-0.00451 (0.00454)	0.0922 (0.353)	-0.0702 (0.341)	-0.0758 (0.341)
Horizontal length _{it} (std)	0.00422 (0.00719)	0.00424 (0.00719)	0.00426 (0.00719)	0.132 (0.546)	-0.186 (0.502)	-0.185 (0.502)
log(total production) _{itm}	-0.000467 (0.00274)	-0.000471 (0.00274)	-0.000480 (0.00274)	0.145 (0.253)	0.0992 (0.236)	0.0985 (0.236)
log(total production) _{itm} ²	0.000166 (0.000160)	0.000166 (0.000160)	0.000166 (0.000160)	0.00453 (0.0151)	0.00505 (0.0137)	0.00503 (0.0137)
Observations	12,732,190	12,732,154	12,732,190	12,732,191	12,732,154	12,732,190
R-squared	0.67	0.67	0.67	0.61	0.67	0.67
Firm FE _i						
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.286	0.286	0.286	24.664	24.664	24.664

Note: This panel reports the baseline specification, except that I add the log of well monthly production and the square of well monthly production as controls. The goal of this approach is to absorb any nonlinear effects of potential changes in production on pollution outcomes. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4) and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. I also include a quadratic polynomial of the log of the well's monthly production as a control. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

B. Natural experiment

	Number of toxic chemicals _{it}		Number of toxic chemicals _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction		0.275** (0.120)		30.338*** (9.760)
BLM × PE-backed _{it} × 2017	0.532*** (0.099)		47.630*** (8.183)	
Vertical depth _{it} (std)	-0.004 (0.005)	-0.005 (0.005)	-0.069 (0.341)	-0.074 (0.339)
Horizontal length _{it} (std)	0.004 (0.007)	0.004 (0.007)	-0.196 (0.499)	-0.209 (0.501)
log(total production) _{itm}	-0.000 (0.003)	-0.000 (0.003)	0.102 (0.236)	0.102 (0.237)
log(total production) _{itm} ²	0.000 (0.000)	0.000 (0.000)	0.005 (0.014)	0.005 (0.014)
Observations	12,732,190	12,732,190	12,732,190	12,732,190
R-squared	0.67	0.67	0.67	0.67
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	0.286	0.286	24.664	24.664

Note: This panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on pollution for Native American reservations and federal lands. The specification includes a quadratic polynomial of the log of the well's monthly production. The variable "Post injunction" takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day the State of California sued the BLM over the rescission) and zero otherwise. The variable "2017" is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. They are both positive, which shows that PE-backed firms increase pollution following a reduction in litigation and compliance risks. The full interaction terms are added in the regressions. The dependent variable of columns (1) and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. I also include a quadratic polynomial of the log of the well's monthly production as a control. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.6: Measures of Toxic Chemical: EPA EHS List (1/2)

A. Baseline effect

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.435*** (0.0962)			-0.127*** (0.0269)		
Post buyout _{it} × Liability risk		-0.0110*** (0.00149)			-0.00339*** (0.000431)	
Post buyout _{it} × High liability risk			-0.476*** (0.0465)			-0.159*** (0.00983)
Vertical depth _{it} (std)	-0.0540 (0.0331)	-0.0539 (0.0332)	-0.0536 (0.0335)	-0.0205*** (0.00735)	-0.0204*** (0.00734)	-0.0203*** (0.00739)
Horizontal length _{it} (std)	0.0373* (0.0205)	0.0368* (0.0202)	0.0337* (0.0201)	0.00920** (0.00463)	0.00932** (0.00462)	0.00836* (0.00460)
First 6 gas _{it} (std)	0.0318 (0.0266)	0.0281 (0.0277)	0.0256 (0.0290)	0.0260 (0.0178)	0.0249 (0.0181)	0.0242 (0.0183)
First 6 oil _{it} (std)	0.00793 (0.0158)	0.00936 (0.0161)	0.0109 (0.0165)	-0.00233 (0.00493)	-0.00211 (0.00500)	-0.00165 (0.00525)
Observations	32,815	32,811	32,811	32,815	32,811	32,811
R-squared	0.74	0.74	0.74	0.72	0.72	0.72
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	1.120	1.120	1.120	0.723	0.723	0.723

Note: The panel reports the impact of PE ownership on pollution as a function of environmental risk. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals comes from the EPA extremely hazardous substances list, as listed in 40 CFR Part 355. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

B. Natural experiment

	Number of toxic chemicals _{it}		Number of toxic chemicals _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction		0.494*** (0.141)		0.151*** (0.0456)
BLM × PE-backed _{it} × 2017	0.658*** (0.184)		0.150*** (0.0465)	
Vertical depth _{it} (std)	0.00896 (0.00583)	0.00877 (0.00580)	0.00710** (0.00354)	0.00704** (0.00354)
Horizontal length _{it} (std)	0.0228*** (0.00588)	0.0228*** (0.00587)	0.00999*** (0.00291)	0.0100*** (0.00290)
First 6 gas _{it} (std)	0.0174** (0.00756)	0.0174** (0.00757)	0.00381 (0.00296)	0.00383 (0.00297)
First 6 oil _{it} (std)	0.00328 (0.00700)	0.00324 (0.00700)	0.0000996 (0.00202)	0.000137 (0.00203)
Observations	156,631	156,631	156,631	156,631
R-squared	0.72	0.72	0.76	0.76
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	0.968	0.968	0.657	0.657

Note: This panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on pollution for Native American reservations and federal lands for PE-backed firms. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day the State of California sued the BLM over the rescission) and zero otherwise. The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. They are both positive, which shows that PE-backed firms increase pollution following a reduction in litigation and compliance risks. The full interaction terms are added in the regressions. The dependent variable of columns (1), and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals comes from the EPA extremely hazardous substances list, as listed in 40 CFR Part 355. The controls include the size (horizontal length and vertical depth) and production (6 first months’ production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.7: Measures of Toxic Chemical: EPA IRIS Database (2/2)

A. Baseline effects

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.890*** (0.286)			-0.106** (0.0425)		
Post buyout _{it} × Liability risk		-0.0249*** (0.00504)			-0.00289*** (0.000871)	
Post buyout _{it} × High liability risk			-1.348*** (0.168)			-0.146*** (0.0249)
Vertical depth _{it} (std)	-0.0646 (0.0391)	-0.0643 (0.0391)	-0.0637 (0.0398)	-0.00701* (0.00359)	-0.00682* (0.00359)	-0.00675* (0.00363)
Horizontal length _{it} (std)	0.0597 (0.0415)	0.0589 (0.0408)	0.0520 (0.0397)	0.00593* (0.00323)	0.00613* (0.00321)	0.00532* (0.00290)
First 6 gas _{it} (std)	-0.00596 (0.0824)	-0.0124 (0.0815)	-0.0167 (0.0799)	0.00931 (0.0111)	0.00900 (0.0112)	0.00845 (0.0114)
First 6 oil _{it} (std)	0.0138 (0.0293)	0.0156 (0.0296)	0.0188 (0.0303)	-0.00626*** (0.00189)	-0.00619*** (0.00189)	-0.00581*** (0.00196)
Observations	32,815	32,811	32,811	32,815	32,811	32,811
R-squared	0.79	0.79	0.79	0.78	0.79	0.79
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	3.170	3.170	3.170	0.826	0.826	0.826

Note: This panel reports the impact of PE ownership on pollution as a function of environmental risk. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. A chemical is defined as toxic if it is mentioned as having an adverse health effect according to the EPA IRIS database. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

B. Natural experiment

	Number of toxic chemicals _{it}		Number of toxic chemicals _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction		0.253** (0.102)		26.751*** (7.450)
BLM × PE-backed _{it} × 2017	0.553*** (0.104)		49.219*** (9.340)	
Vertical depth _{it} (std)	0.000 (0.004)	0.000 (0.004)	0.126 (0.284)	0.107 (0.282)
Horizontal length _{it} (std)	0.008 (0.006)	0.008 (0.006)	0.253 (0.409)	0.251 (0.409)
First 6 gas _{it} (std)	-0.003 (0.004)	-0.003 (0.004)	0.020 (0.321)	0.018 (0.321)
First 6 oil _{it} (std)	-0.000 (0.003)	-0.000 (0.003)	0.004 (0.266)	0.004 (0.266)
Observations	156,631	156,631	156,631	156,631
R-squared	0.66	0.66	0.66	0.66
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	2.662	2.662	0.777	0.777

Note: This panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on pollution for Native American reservations and federal lands for PE-backed firms. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day the State of California sued the BLM over the rescission) and zero otherwise. The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. They are both positive, which shows that PE-backed firms increase pollution following a reduction in litigation and compliance risks. The full interaction terms are added in the regressions. The dependent variable of columns (1), and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. A chemical is defined as toxic if it is mentioned as having an adverse health effect according to the EPA IRIS database. The controls include the size (horizontal length and vertical depth) and production (6 first months’ production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.8: Poisson Regression**A. Baseline effects**

	Nb of confidential items _{it}			(Nb of confidential items _{it} > 0)		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.377*** (0.0779)			-0.326*** (0.0813)		
Post buyout _{it} × Liability risk		-0.00999*** (0.00189)			-0.00852*** (0.00211)	
Post buyout _{it} × High liability risk			-0.487*** (0.0829)			-0.393*** (0.0922)
Vertical depth _{it} (std)	-0.00000527 (0.0134)	0.0000133 (0.0134)	0.0000965 (0.0134)	0.00371 (0.0118)	0.00373 (0.0118)	0.00381 (0.0118)
Horizontal length _{it} (std)	0.0273* (0.0160)	0.0273* (0.0160)	0.0273* (0.0160)	0.0140 (0.0137)	0.0140 (0.0137)	0.0141 (0.0138)
First 6 gas _{it} (std)	0.00147 (0.0129)	0.00148 (0.0129)	0.00158 (0.0129)	0.0107 (0.0111)	0.0107 (0.0111)	0.0108 (0.0111)
First 6 oil _{it} (std)	0.00123 (0.00732)	0.00122 (0.00732)	0.00121 (0.00732)	-0.00102 (0.00789)	-0.00103 (0.00789)	-0.00104 (0.00789)
Observations	88,953	88,953	88,953	88,953	88,953	88,953
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.319	0.319	0.319	27.429	27.429	27.429

Note: This panel reports the impact of PE ownership on pollution as a function of environmental risk, where the specifications are estimated using a Poisson regression. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

B. Natural experiment

	Number of toxic chemicals _{it}		Number of toxic chemicals _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction		0.361 (0.274)		0.422* (0.243)
BLM × PE-backed _{it} × 2017	0.906*** (0.348)		0.884** (0.364)	
Vertical depth _{it} (std)	-0.000265 (0.0134)	-0.000657 (0.0134)	0.00362 (0.0118)	0.00316 (0.0117)
Horizontal length _{it} (std)	0.0270* (0.0161)	0.0269* (0.0161)	0.0138 (0.0138)	0.0137 (0.0137)
First 6 gas _{it} (std)	0.00163 (0.0130)	0.00146 (0.0130)	0.0108 (0.0111)	0.0107 (0.0111)
First 6 oil _{it} (std)	0.00116 (0.00733)	0.00115 (0.00732)	-0.00102 (0.00793)	-0.00111 (0.00792)
Observations	88,953	88,953	88,953	88,953
R-squared				
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	0.319	0.319	27.429	27.429

Note: This panel reports a triple difference-in-differences specification that estimates, using a Poisson regression, the differential impact of the BLM litigation on pollution for Native American reservations and federal lands. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day the State of California sued the BLM over the rescission) and zero otherwise. The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. They are both positive, which shows that PE-backed firms increase pollution following a reduction in litigation and compliance risks. The full interaction terms are added in the regressions. The dependent variable of columns (1), and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months’ production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.9: Natural Experiment Using Only Federal Land

	Number of toxic chemicals _{it}		Number of toxic chemicals _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction		0.255** (0.101)		24.827*** (7.679)
BLM × PE-backed _{it} × 2017	0.558*** (0.106)		47.044*** (9.685)	
Vertical depth _{it} (std)	0.000 (0.004)	0.000 (0.004)	0.126 (0.284)	0.108 (0.282)
Horizontal length _{it} (std)	0.008 (0.006)	0.008 (0.006)	0.253 (0.409)	0.251 (0.410)
First 6 gas _{it} (std)	-0.003 (0.004)	-0.003 (0.004)	0.020 (0.321)	0.018 (0.321)
First 6 oil _{it} (std)	-0.000 (0.003)	-0.000 (0.003)	0.005 (0.266)	0.005 (0.266)
Observations	156,631	156,631	156,631	156,631
R-squared	0.66	0.66	0.66	0.66
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	0.319	0.319	27.429	27.429

Note: This panel replicates the natural experiment, but by dropping the lands that come from Native American reservations, and focusing entirely on federal land. Specifically, the panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on pollution for federal lands for PE-backed firms. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day the State of California sued the BLM over the rescission) and zero otherwise. The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. They are both positive, which shows that PE-backed firms increase pollution following a reduction in litigation and compliance risks. The full interaction terms are added in the regressions. The dependent variable of columns (1), and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months’ production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.10: Alternative Proxy for Environmental Risk: PE Buyout

	Nb of confidential items _{it}			
	(1)	(2)	(3)	(4)
Post buyout _{it} × High enforcement	-0.199*** (0.0543)		-15.52*** (3.976)	
Post buyout _{it} × High enforcement × High liability risk		-0.250*** (0.0368)		-0.250*** (0.0368)
Vertical depth _{it} (std)	0.000276 (0.00389)	0.000213 (0.00390)	0.124 (0.284)	0.000213 (0.00390)
Horizontal length _{it} (std)	0.00836 (0.00583)	0.00837 (0.00583)	0.264 (0.410)	0.00837 (0.00583)
First 6 gas _{it} (std)	-0.00301 (0.00432)	-0.00301 (0.00432)	0.0161 (0.321)	-0.00301 (0.00432)
First 6 oil _{it} (std)	-0.0000850 (0.00295)	-0.0000263 (0.00295)	0.00107 (0.265)	-0.0000263 (0.00295)
Observations	156,631	156,631	156,631	156,631
R-squared	0.66	0.66	0.66	0.66
Firm FE _i				
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Mean Dep. Var.	0.319	0.319	0.319	0.319

Note: This table shows the impact of PE buyout as a function of environmental liability risk, using an alternative proxy. I use the variable High enforcement, a dummy variable that takes the value one if the project is located in an area with high enforcement actions and inspections and zero otherwise. All regressions include state year fixed effects. The dependent variable of columns (1) and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value one if the well is using at least one toxic chemical and zero otherwise. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.11: Alternative Proxy for Environmental Risk: PE DrillCo

	Nb of confidential items _{it}			
	(1)	(2)	(3)	(4)
Post DrillCo _{it} × High enforcement	0.0378 (0.0744)		4.021 (6.291)	
Post DrillCo _{it} × High enforcement × High liability risk		-0.0512 (0.193)		-0.0512 (0.193)
Vertical depth _{it} (std)	0.000254 (0.00389)	0.000243 (0.00389)	0.122 (0.284)	0.000243 (0.00389)
Horizontal length _{it} (std)	0.00831 (0.00583)	0.00831 (0.00582)	0.260 (0.410)	0.00831 (0.00582)
First 6 gas _{it} (std)	-0.00302 (0.00432)	-0.00301 (0.00432)	0.0157 (0.321)	-0.00301 (0.00432)
First 6 oil _{it} (std)	-0.0000198 (0.00295)	-0.0000291 (0.00295)	0.00630 (0.265)	-0.0000291 (0.00295)
Observations	156,631	156,631	156,631	156,631
R-squared	0.66	0.66	0.66	0.66
Firm FE _i				
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Mean Dep. Var.	0.319	0.319	27.429	27.429

Note: The table shows the impact of PE DrillCo contracts as a function of environmental liability risk, using an alternative proxy. I use the variable High enforcement, a dummy variable that takes the value one if the project is located in an area with high enforcement actions and inspections and zero otherwise. All regressions include state year fixed effects. The dependent variable of columns (1) and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value one if the well is using at least one toxic chemical and zero otherwise. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Standard errors are clustered at the firm level.

Table A.12: Baseline Specification: Double Clustering

A. Baseline effects

	Number of toxic chemicals _{it}			Number of toxic chemicals _{it} > 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Post buyout _{it}	-0.244*** (0.0838)			-16.93*** (5.412)		
Post buyout _{it} × Liability risk		-0.00507*** (0.00118)			-0.418*** (0.0942)	
Post buyout _{it} × High liability risk			-0.233*** (0.0436)			-18.87*** (3.966)
Vertical depth _{it} (std)	0.00259 (0.00429)	0.000249 (0.00380)	0.000209 (0.00381)	0.294 (0.303)	0.122 (0.282)	0.118 (0.282)
Horizontal length _{it} (std)	0.00950 (0.00585)	0.00835 (0.00566)	0.00835 (0.00566)	0.312 (0.430)	0.264 (0.398)	0.264 (0.397)
First 6 gas _{it} (std)	-0.00378 (0.00473)	-0.00301 (0.00425)	-0.00301 (0.00425)	-0.0223 (0.341)	0.0160 (0.319)	0.0162 (0.319)
First 6 oil _{it} (std)	0.000430 (0.00394)	-0.0000654 (0.00301)	-0.0000245 (0.00300)	0.145 (0.307)	0.00243 (0.267)	0.00580 (0.267)
Observations	157,214	156,631	156,631	157,214	156,631	156,631
R-squared	0.58	0.66	0.66	0.59	0.66	0.66
Firm FE _i	x			x		
Firm FE _i × year FE _t		x	x		x	x
State FE _i × year FE _t	x	x	x	x	x	x
Location _j × year FE _t	x	x	x	x	x	x
Mean Dep. Var.	0.319	0.319	0.319	27.429	27.429	27.429

Note: This panel reports the impact of PE ownership on pollution as a function of environmental risk, where the standard errors are two-way clustered at the firm and location level. The dependent variable of columns (1), (2), and (3) is the number of toxic chemicals used per well. The dependent variable of columns (3), (4), and (5) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months' production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

B. Natural experiment

	Number of toxic chemicals _{it}		Number of toxic chemicals _{it} > 0	
	(1)	(2)	(3)	(4)
BLM × PE-backed _{it} × Post injunction		0.260*** (0.0874)		25.79*** (6.536)
BLM × PE-backed _{it} × 2007	0.499*** (0.0938)		43.83*** (10.16)	
Vertical depth _{it} (std)	0.00245 (0.00445)	0.00229 (0.00443)	0.376 (0.338)	0.361 (0.335)
Horizontal length _{it} (std)	0.0121 (0.00741)	0.0121 (0.00741)	0.433 (0.545)	0.432 (0.545)
First 6 gas _{it} (std)	-0.00117 (0.00359)	-0.00117 (0.00359)	0.212 (0.290)	0.211 (0.289)
First 6 oil _{it} (std)	-0.000260 (0.00364)	-0.000237 (0.00364)	0.00678 (0.331)	0.00628 (0.331)
Observations	161,011	161,011	161,011	161,011
R-squared	0.53	0.53	0.53	0.53
Firm FE _i × year FE _t	x	x	x	x
State FE _i × year FE _t	x	x	x	x
Location _j × year FE _t	x	x	x	x
Project-level controls _{it}	x	x	x	x
Mean Dep. Var.	0.319	0.319	27.429	27.429

Note: This panel reports a triple difference-in-differences specification that estimates the differential impact of the BLM litigation on pollution for Native American reservations and federal lands, where the standard errors are two-way clustered at the firm and location level. The variable “Post injunction” takes the value one if the project starts during the period from September 30, 2015 (the day of the preliminary injunction) through January 24, 2018 (the day the State of California sued the BLM over the rescission) and zero otherwise. The variable “2017” is a dummy that takes the value one for the year 2017, when the fracking rule was abrogated by the Trump administration, and zero otherwise. The two coefficients of particular interest are BLM × Post buyout × Post injunction and BLM × Post buyout × 2017. They are both positive, which shows that PE-backed firms increase pollution following a reduction in litigation and compliance risks. The full interaction terms are added in the regressions. The dependent variable of columns (1) and (2) is the number of toxic chemicals used per well. The dependent variable of columns (3) and (4) is a dummy that takes the value 100 if the well is using at least one toxic chemical and zero otherwise. The list of toxic chemicals can be found in Table 1. The controls include the size (horizontal length and vertical depth) and production (6 first months’ production of oil and gas) of the well. The controls are standardized to a mean of 0 and a standard deviation of 1. The symbols *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table A.13: Common Trend Assumption: Statistics**A. Net impact of Buyout and DrillCo**

	Net impact of PE		Net impact of DrillCo	
	Number of chemicals	Extensive margin	Number of chemicals	Extensive margin
LR	8.94E-24	0.00015	2.98E-18	0.00019
Bayes	0.22	0.22	0.23	0.22
Power	0.80	0.80	0.80	0.80

B. Role of Risks

	Net impact of PE (function of risks)		Net impact of DrillCo (function of risks)	
	Number of chemicals	Extensive margin	Number of chemicals	Extensive margin
LR	8.61E-10	8.90502E-05	1.28E-17	5.11E-17
Bayes	0.22	0.22	0.23	0.22
Power	0.80	0.80	0.80	0.80

Note: This table reports different statistics to evaluate whether a linear pre-trend with a power of 80% drives the baseline results. I choose 80% following Roth (2022), since it is often used as a benchmark for the minimum detectable effect in power analyses (Cohen (2013)). LR (likelihood ratio) is the ratio of the likelihood of the observed coefficients under the hypothesized trend relative to parallel trends. The Bayes ratio is the ratio of the probability of “passing” the pre-test under the hypothesized trend relative to parallel trends. The smaller the LR or the Bayes ratio is, the more credible the common trend assumption is relative to the hypothesized trend. The statistics are small and close to zero, bringing more confidence to the idea that a pre-trend is not driving the results.

Table A.14: Robustness of a pre-trend violation: smoothness restrictions**A.Extensive Margin**

Calibration	Net impact of PE	Net impact of DrillCo	Net impact of PE (function of risks)	Net impact of DrillCo (function of risks)
0.00	-5.94	4.04	-28.63	14.17
0.20	-5.92	8.85	-28.62	21.15
0.40	-5.84	8.36	-28.54	30.62
0.60	-5.70	7.55	-28.47	35.51
0.80	-5.48	6.46	-28.33	35.01
1.00	-5.17	6.40	-28.16	34.33
1.20	-4.71	5.23	-27.96	33.51

B. Number of Chemicals

Calibration	Net impact of PE	Net impact of DrillCo	Net impact of PE (function of risks)	Net impact of DrillCo (function of risks)
0.001	-0.078	0.251	-0.125	0.660
0.002	-0.078	0.249	-0.125	0.659
0.003	-0.078	0.247	-0.125	0.656
0.004	-0.077	0.243	-0.124	0.652
0.005	-0.076	0.237	-0.124	0.647
0.006	-0.075	0.230	-0.123	0.641

Note: This table reports a sensitivity analysis based on smoothness restrictions, following [Rambachan and Roth \(2023\)](#). More specifically, the table reports the coefficient of the impact of PE buyout on pollution if the slope of the difference in trend changes is a multiple of the average difference in pollution for a same firm over two consecutive projects. The average difference in pollution within firms in the extensive margin is 0.133, and the average difference in the number of toxic chemicals used within firms is (in absolute value) 0.0018. Panel A shows the robustness tests when the dependent variable is a dummy variable that takes the value one if the well has at least one toxic chemical and 0 otherwise. Panel B focuses on the number of toxic chemicals. Overall, the tests support the view that the signs of the baseline results are robust to several hypothesized violations of the common trend assumption after the shock.

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