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# Regulatory Fracture Plugging: Managing Risks to Water From Shale Development

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# ARTICLE

# REGULATORY FRACTURE PLUGGING: MANAGING RISKS TO WATER FROM SHALE DEVELOPMENT

*by: Caroline Cecot**

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## I. Introduction

Deep shale formations in the United States have long been known to hold large quantities of gas and oil, but their low permeability made energy extraction challenging and unprofitable. In recent years, operators combined two techniques to increase well productivity: horizontal drilling, which exposes more shale rock to the wellbore; and hydraulic fracturing, which injects large quantities of water mixed with chemicals and sand at high pressure to create and prop open tiny fractures that allow trapped gas and oil to flow into the wellbore (collectively, fracking).[1] Fracking, combined with the high price of natural gas in the mid-2000s, set off a drilling boom that exposed more areas, including heavily populated and environmentally sensitive areas, to the risks associated with drilling activities. Debates about the desirability of widespread shale development have highlighted outstanding uncertainty about its health, safety, and environmental impacts—most

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1. U.S. Dep't of Energy, Nat'l Energy Tech. Lab., DE-FE0004002, Modern Shale Gas Development in the United States: An Update 11–12 (2013). This Article refers to the application of both technologies, horizontal drilling and hydraulic fracturing, as fracking. These technologies have also been referred to as "fracing." Both horizontal drilling and hydraulic fracturing technologies are used to extract oil or gas from unconventional, shale, or tight formations—but hydraulic fracturing is also used with vertical wells drilled in conventional formations.

prominently, its water-contamination risks—and the ability of current institutions to deal with these impacts.[2] States, the primary regulators of oil and gas extraction, face pressure from the energy industry, local communities, and, in some cases, the federal government to strike the right balance between energy production and the health and safety of individuals and the environment—an elusive balance given the ongoing risk uncertainty. Concerns that current public and private risk-management systems cannot deal with potential fracking-related risks have led many towns, cities, and states to take a precautionary approach by banning fracking altogether.[3] This dynamic is not especially unique to fracking, or even oil and gas extraction; instead, this dynamic, characterized by tradeoffs between environmental protection and economic development under risk uncertainty, is a common theme of environmental risk regulation. Regulators at every level of government weigh and evaluate potential interventions against this background.

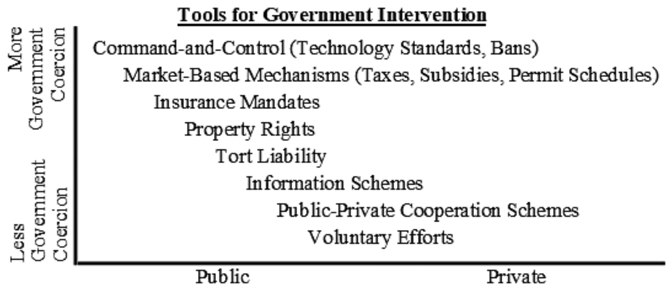
This Article contributes to a symposium held at Texas A&M School of Law that explored the advantages and disadvantages of various government interventions in the environmental context in an effort to identify ideal risk-management tools under various circumstances.[4] Federal and state governments have several tools at their disposal to achieve environmental policy ends. Figure 1 presents some of the most commonly discussed tools organized by degree of government involvement and coercion, two important themes of the symposium.

2. U.S. Gov't Accountability Off., GAO-12-732, Oil & Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks 39, 50 (2012).

3. *See, e.g.*, Caroline Cecot, *No Fracking Way: An Empirical Investigation of Local Shale Development Bans in New York*, 48 Envtl. L. (forthcoming 2018) (finding that towns more vulnerable to water risks, among other things, were more likely to adopt fracking bans in New York). According to the environmental group Food and Water Watch, more than 400 communities across more than twenty states as well as five states and the District of Columbia have adopted some anti-fracking measure. *See Local Resolutions Against Fracking*, Food & Water Watch, http://www.foodandwaterwatch.org/insight/local-resolutions-against-fracking (last updated May 18, 2018) [https://perma.cc/8EPS-75BV].

4. *Environmental Protection: Carrots or Sticks?* at Texas A&M School of Law on March 9–10, 2018.

FIGURE 1




Of course, the ideal tool depends on the context. And contributions to this symposium discuss the potential usefulness of using command-and-control options,[5] tort liability,[6] market-based mechanisms,[7] and public-private cooperation schemes[8] in a variety of contexts. This Article highlights how, in some circumstances, the government should deploy a combination of tools that would work in concert to manage risk. In particular, it focuses on interventions that would help address risks to water from fracking.

From an economic perspective, the goal of environmental policy should be the level of environmental quality that maximizes aggregate welfare. Then, the ideal tool is the one that would achieve that goal at the lowest cost to society (including administrative, compliance, enforcement, and other costs). Identifying this tool or combination of tools requires grappling with the nature of the specific environmental externality, the incentives of various actors, and the comprehensiveness of existing regulation-based, market-based, or litigation-based risk management. The most important considerations for identifying risk-management tools in the environmental context, then, are risks, incentives, and cost-benefit analysis. These cornerstone principles provide a useful framework for environmental policy in general, especially in situations that involve heterogeneous and uncertain risks. By paying attention to risk, incentives, and cost-benefit analysis, government regulators are more likely to promote optimal levels of environmental quality and avoid unintended, or even perverse, consequences.

To demonstrate the usefulness of these concepts concretely, this Article applies them to the fracking context, focusing on the most prominent risks from widespread shale development: risks to water from

5. *See, e.g.*, Katrina M. Wyman, *Unilateral Steps to End High Seas Fishing*, 6 TEX. A&M L. REV. 259 (2018).

6. *See, e.g.*, Robin Kundis Craig, *Drought and Public Necessity: Can a Common-Law "Stick" Increase Flexibility in Western Water Law*, 6 TEX. A&M L. REV. 77 (2018).

7. *See, e.g.*, James Salzman et al., *Payments for Ecosystem Services: Past, Present and Future*, 6 TEX. A&M L. REV. 199 (2018).

8. *See, e.g.*, Jonathan M. Gilligan, *Carrots and Sticks in Private Climate Governance*, 6 TEX. A&M L. REV. 179 (2018).

shale gas extraction. Among industry experts and regulators, the most concerning risks relate to the potential for spills of fracking fluid—which can contain hazardous chemicals—and drilling wastewater—which can contain residual fracking fluid, brine, and naturally occurring contaminants from the formation itself.[9] There is considerable uncertainty about the nature and magnitude of risks to water from fracking itself or from spills of fracking-related fluids and disagreement about the ability of private and public institutions to efficiently and comprehensively manage the risks. This Article applies these principles in order to identify risk-management gaps in current regulatory frameworks and suggest potential solutions.

The Article is organized as follows. Part II briefly defends the usefulness of the economic perspective for environmental policy in general. Paying attention to risks, incentives, and cost-benefit analysis is self-evident to those who subscribe to the economic perspective, believe that welfare maximization is an appropriate goal for environmental policy, and think that government interventions can, in some cases, improve aggregate welfare. Of course, these principles are susceptible to the criticisms of the economic perspective. Part III introduces the context of shale development and categorizes the relevant risks along two useful dimensions. Part IV examines the ability of current risk-management systems to manage the relevant risks. The Article highlights several risk-management gaps and offers suggestions on specific tools that can be used to address these gaps. In particular, the Article argues that states could better manage the risks to water from shale development by clarifying tort responsibility, mandating specific insurance, using economic analysis to assess regulatory safeguards, and encouraging research.

## II. Defending Economics in Environmental Policy

Applying principles of welfare economics, economic theory identifies the socially desirable level of environmental quality as the level that maximizes aggregate welfare, as measured by the satisfaction of individual preferences.[10] In this way, the economic perspective pro-

9. *See* Alan Krupnick et al., Pathways to Dialogue What the Experts Say about the Environmental Risks of Shale Gas Development, Resources for the Future 36 (2013), http://www.rff.org/files/sharepoint/Documents/RFF-Rpt-PathwaystoDialogue_FullReport.pdf [https://perma.cc/5CHY-X87E]. The Article does not address the risk of earthquakes from the *disposal* of fracking waste waters, a risk that has been well-documented. *See Induced Earthquakes*, U.S. Geological Surv., https://earthquake.usgs.gov/research/induced/myths.php [https://perma.cc/VB8A-LKXJ]. That said, increased wastewater recycling could mitigate this risk. *See* Nichola Groom, *Fracking Water's Dirty Secret—Recycling,* Sci. Am., https://www.scientificamerican.com/article/analysis-fracking-waters-dirty-secret/ [https://perma.cc/LW2V-FY5F].

10. For a discussion of general welfare economics, see Andreu Mas-Colell, Michael D. Whinston & Jerry R. Green, Microeconomic Theory 545–72 (1995). Some disagree on whether a human-focused approach is appropriate in the

vides a way of organizing competing interests and considering difficult tradeoffs. It identifies a specific and achievable goal for environmental quality, and its intuitions can be supplemented with insights from other perspectives.

Standard economic theory predicts that well-functioning free markets allocate scarce resources efficiently, without need for government intervention. No one's welfare can be improved without making someone else worse off.[11] And, assuming no market failure, the market outcome also maximizes aggregate welfare.

But market failure can and does occur. One common market failure involves unpriced effects on third parties, referred to as externalities. The idea is that if the market took account of these effects, the welfare-maximizing equilibrium outcome would actually have been higher (positive externalities) or lower (negative externalities). In some cases, an apparent externality can be internalized by private parties, thereby correcting the market failure without any outside intervention. For example, if transaction costs were small and property rights were well-defined, private parties would bargain with each other, and the unpriced effects would be priced, the externality eliminated, and social welfare maximized.[12] In the environmental context, however, there are many situations where transaction costs are high and property rights are incomplete, such as when water pollution affects a large downstream population. Economic theory thus supports government intervention that would lower transaction costs, define property rights, or otherwise encourage market participants to internalize the effects of the externality.

Of course, although government intervention might be necessary to achieve the optimal level of environmental quality when markets and private bargaining fail, the actual intervention might not improve welfare, or even environmental quality, as compared to the status quo. Government intervention might itself be inefficient—under- or over-

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environmental context and whether individual preference satisfaction is the proper basis for social welfare. *E.g.*, Mark Sagoff, *On Preserving the Natural Environment*, 84 YALE L.J. 205, 223–25 (1974); James Huffman, *Governing America's Resources: Federalism in the 1980's*, 12 ENVTL. L. 863, 863–90 (1982); Rena I. Steinzor, *Devolution and the Public Health*, 24 HARV. ENVTL. L. REV. 351, 366–69 (2000); Oliver A. Houck, *Noah's Second Voyage: The Rights of Nature as Law*, 31 TUL. ENVTL. L.J. 1, 33–34 (2017). For a more detailed account of contemporary welfare economics, see MATTHEW D. ADLER, WELL-BEING AND FAIR DISTRIBUTION: BEYOND COST-BENEFIT ANALYSIS (2011).

11. *See* VILFREDO PARETO, COURS D'ÉCONOMIE POLITIQUE (1896) (explaining this quality of the equilibrium market outcome, which is referred to as *Pareto* efficiency).

12. R. H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 19 (1960). Note that the assignment of property rights does not affect the resulting output. Of course, it determines which party makes payments and which party receives them, which is a distributional concern, not an efficiency concern. *See id.* at 30.

regulating.[13] The economic perspective helps here, too, with its framework for identifying the appropriate level of environmental quality. And in choosing among tools for achieving this goal, the economic perspective focuses on efficiency or cost-effectiveness by evaluating which instrument is likely to achieve the identified policy goals at the lowest possible cost to society, including overall implementation costs. This inquiry could include any costs attributable to inefficiencies associated with more government involvement as well as costs related to enforcement and implementation.

In particular, cost-benefit analysis can be used to account for various interests and shed light on social-welfare-improving policies. The analysis converts the value of the expected benefits to the beneficiaries of a policy and the expected costs to those who are burdened by the policy into a monetary scale and attempts to maximize net benefits.[14] At the very least, it forces regulators to explicitly list, quantify, and, when possible, monetize the expected effects and consider alternatives that might achieve similar goals at a lower cost. Cost-benefit analysis can increase the efficiency of environmental policies regardless of the regulatory instrument that decision-makers ultimately choose.[15] This tool is gaining widespread acceptance, notwithstanding lingering methodological challenges and opposition.[16] Since at least 1981, cost-benefit analysis serves as the analytical framework for the

13. There is a large amount of literature on what is referred to as "government failure." *See, e.g.*, CLIFFORD WINSTON, GOVERNMENT FAILURE VERSUS MARKET FAILURE (2006). Some argue that the potential for government failure must be weighed against the original market failure. *E.g.*, Terry L. Anderson & Donald R. Leal, *Free Market Environmentalism: Hindsight and Foresight*, 8 CORNELL J.L. & PUB. POL'Y 111, 123 (1998). Undoubtedly, as underscored by the public choice literature, an investigation into the various incentives of government actors is important. But currently, there appears to be little empirical information about the prevalence and magnitude of government failure in the environmental context.

14. In other words, it implements the *Kaldor-Hicks* criterion, favoring policies in which the beneficiaries could theoretically compensate those burdened. In other words, it expands the universe of welfare-improving policies beyond those identified by the *Pareto* criterion, which favors policies that benefit at least one person while making no other person worse off. For a welfare-based justification for cost-benefit analysis that does not rely on the *Kaldor-Hicks* criterion, see MATTHEW D. ADLER & ERIC A. POSNER, NEW FOUNDATIONS OF COST-BENEFIT ANALYSIS (2006).

15. Well-designed command-and-control policies that are informed by economic principles might even be superior in some contexts to market-based policies. *See, e.g.*, Wallace E. Oates, Paul R. Portney & Albert M. McGartland, *The Net Benefits of Incentive-Based Regulation: A Case Study of Environmental Standard Setting*, 79 AM. ECON. REV. 1233, 1241–42 (1989).

16. These criticisms have been well-documented, including the difficulty of quantifying and monetizing certain impacts and the importance of distributional concerns that are typically not included in the analyses. *See, e.g.*, Douglas A. Kysar, *It Might Have Been: Risk, Precaution and Opportunity Costs*, 22 J. LAND USE & ENVTL. L. 1, 6 (2006); ADLER, *supra* note 10, at 6; Scott Farrow, *Incorporating Equity in Regulatory and Benefit-Cost Analysis Using Risk Based Preferences*, 31 RISK ANALYSIS 902, 902–04 (2011).

design and evaluation of federal regulatory policy and wields wide influence on the stringency of federal environmental policy.[17]

This Article applies these economic principles to identify optimal regulation of risks to water from shale development. The regulation of shale development is left largely to the states.[18] Unlike federal regulation, state regulation is not governed by any cross-cutting analytical framework such as cost-benefit analysis. In fact, the economic perspective, in general, has not gained as much influence in state regulation.

## III. Fracking Context and Risks

As an initial matter, it is important to consider the existence and nature of externalities in the shale development context. When property owners possess both surface and mineral rights, an oil and gas operator seeking to drill a well spanning several property tracts would need to receive permission from all of the relevant property owners.[19] Property owners typically accept rental and royalty payments from oil and gas companies in exchange for leasing mineral rights to operators. In deciding whether to lease mineral rights, a property owner weighs these rental and royalty payments against the potential adverse environmental, health, and safety effects of drilling on her property. After weighing the private costs and benefits, the property owner decides whether to enter into an oil and gas lease.

17. *E.g.*, Economic Analyses at EPA: Assessing Regulatory Impact 10–12 (Richard D. Morgenstern ed., Res. for the Future 1997); Thomas O. McGarity, *A Cost-Benefit State*, 50 Admin. L. Rev. 7, 10, 15–16 (1998); Cass R. Sunstein, The Cost-Benefit State: The Future Of Regulatory Protection 9–12 (2002); Richard L. Revesz & Michael A. Livermore, Retaking Rationality: How Cost-Benefit Analysis Can Better Protect the Environment and Our Health 3–5 (2008). In fact, the tool of cost-benefit analysis, or at least an informal version of the tool, is increasingly associated by courts with rational federal agency decision-making. *See* Caroline Cecot & W. Kip Viscusi, *Judicial Review of Agency Benefit-Cost Analysis*, 22 Geo. Mason L. Rev. 575, 592–605 (2015) (examining how courts review agency cost-benefit analysis); Cass R. Sunstein, *Cost-Benefit Analysis and Arbitrariness Review*, 41 Harv. Envtl. L. Rev. 1, 2–4 (2017) (arguing that, to survive arbitrariness review, agencies should conduct reasonable cost-benefit analysis).

18. This Article treats this distribution of authority as a given but acknowledges that much ink has been spilled on the optimal jurisdictional allocation. *See, e.g.*, David B. Spence, *Federalism, Regulatory Lags, and the Political Economy of Energy Production*, 161 U. Pa. L. Rev. 431, 435–47 (2013); Michael Burger, *Fracking and Federalism Choice*, 161 U. Pa. L. Rev. PENNumbra 150, 153–60 (2013).

19. In some instances, one party will own both the surface area and the mineral estate beneath the land. However, if the surface rights and mineral estate rights have been severed, these rights will be owned by different parties. In cases where mineral rights and surface rights are held separately (a split-estate), it is even easier to contemplate the existence of externalities. But at least in some cases the surface owner could negotiate compensation for protection from "unreasonable encroachment and damage" to the surface. *See* Anthony Andrews, et al., Unconventional Gas Shales: Development, Technology, and Policy Issues, Cong. Res. Serv. 27 (2010).

It is clear, then, that at least some of the risks of fracking can be, and often are, internalized. The operator and the property owner should negotiate until the royalty rate and the terms of the lease adequately reflect (1) the expected economic rent; (2) characteristics of the resource; (3) competition for the lease, such as the number of other producers offering leases in the area, and the number of other nearby mineral owners currently negotiating with a producer; and (4) environmental effects on the leaseholder's property.[20] At least one empirical study of leases confirms that some contain environmental clauses that encourage the use of safeguards to prevent contamination of soil and water and noise clauses that require the use of mufflers with loud equipment.[21] The empirical analysis, however, also suggests that concerns about information asymmetries and unequal bargaining power are not out of place in this context.[22]

But even putting aside concerns about information and bargaining power, it is equally clear that the lease agreement between the property owner and the operator does not internalize all the effects on water from shale development.[23] The unprecedented scale of development exposes more areas to ordinary risks associated with drilling activities, including wastewater spills on the surface or methane leaks due to improper well casing.[24] Fracking might also present additional risks, such as groundwater and surface water contamination from fracking fluid or wastewater.[25] These risks can easily extend beyond the properties of the lessors. It is difficult to measure the extent of these externalities. One study of Pennsylvania, where shale gas devel-

20. *See The Basics: Mineral Rights, Royalties & Surface Use Agreements*, COLO. OIL & GAS ASS'N (2013), http://www.coga.org/wp-content/uploads/2015/09/3-Basics_MineralRights.pdf [https://perma.cc/UPH7-36HU]; Christopher Timmins & Ashley Vissing, *Shale Gas Leases: Is Bargaining Efficient and What Are the Implications for Homeowners if it is Not?* 2, 14 (Dept. of Econ., Duke Univ., Working Paper, 2014), http://public.econ.duke.edu/~timmins/Timmins_Vissing_11_15.pdf [https://perma.cc/2SUW-2UTV]; Jayni Foley Hein & Caroline Cecot, *Mineral Royalties: Historical Uses and Justifications*, 28 DUKE ENVTL. L. & POL'Y F. 1, 27 (2017).

21. Timmins & Vissing, *supra* note 20, at 72.

22. *See* Jeffrey R. Ray, *Shale Gas: Evolving Global Issues for the Environment, Regulation, and Energy Security,* 2 LSU J. ENERGY L. & RES. 75, 88–89 (2013). The empirical study of leases also found that demographic factors are associated with negotiation power, with high-income mineral owners able to negotiate higher royalty rates. Timmins & Vissing, *supra* note 20, at 40–41. To the extent that there are inefficiencies in the lease terms, some government involvement might improve outcomes. For example, some states have enacted laws that guarantee a minimum royalty rate to private landowners or otherwise regulate the calculation of royalty payments. *See, e.g.*, W. VA. CODE § 22-21-17 (2009); 58 PA. CONS. STAT. § 33 (1979); 58 PA. STAT. ANN. § 33 (2012); 2012 N.C. Sess. Laws 679–80, N.C. GEN. STAT. § 113-423(c) (2012). But those issues are outside the scope of this Article. This Article focuses on the regulation of environmental *externalities*.

23. *See* Ray, *supra* note 22. There may also be positive externalities from shale development that are likely not internalized.

24. *See* Yusuke Kuwayama et. al, *Water Quality and Quantity Impacts of Hydraulic Fracturing*, 2 CURRENT SUSTAINABLE/RENEWABLE ENERGY REP. 17, 22 (2015).

25. *Id.* at 20.

opment is prevalent, estimated that an additional well pad drilled within 1 km of a groundwater intake area for a community water system increased shale gas-related contaminants by, on average, 1.5 to 2.7%.[26] Nearby property owners who did not lease their mineral rights would face these water-contamination risks of drilling activities. And those who rely on private water wells for drinking water might be especially vulnerable to water risks.[27] Another study estimated that those living in Pennsylvania counties with shale development spent more than $19 million on bottled water in 2010 due to perceived risks to drinking water.[28]

As shale development increases and properties have multiple nearby wells, the ability of property owners to negotiate a solution with oil and gas operators diminishes. If the regulatory regime is not comprehensive, then some property owners might face a version of the prisoner's dilemma: These property owners might prefer to avoid oil and gas drilling on their lands—but only if their neighbors also do not allow oil and gas drilling on their lands. But if their neighbors allowed drilling, then they would rather allow drilling, too. Otherwise, these property owners would bear the costs of the drilling in the form of unmitigated risks and uncompensated damages and would gain none of the rewards in the form of royalty and rental payments. If these types of property owners constitute a majority in a locality, then they might decide to ban drilling altogether.[29] In fact, in other research, I found evidence that suggests concern about risks to water has motivated some banning behavior.[30] Given that shale development is thought to have positive externalities beyond the local level,[31] welfare could be improved by avoiding bans through more comprehensive regulation of externalities that would mitigate risks or compensate damages. In 2012, the International Energy Agency warned firms to support regulations that deal convincingly with environmental risks of fracking—which it estimated would raise production costs by

26. Elaine Hill & Lala Ma, *Shale Gas Development and Drinking Water Quality*, 107 AM. ECON. REV. 522, 522 (2017).

27. *See id.* at 22. Unlike with the public water system, states do not regulate private water wells, leaving it up to the homeowner to ensure that the water supply is safe for consumption. Property owners who rely on private water wells, therefore, would be expected to have a higher probability of realizing poor water quality if a nearby well damages water sources.

28. Douglas H. Wrenn et al., *Unconventional Shale Gas Development, Risk Perceptions, and Averting Behavior: Evidence from Bottled Water Purchases*, 3 J. ASS'N ENVTL. & RES. ECONOMISTS 779, 779 (2016).

29. *See generally* Cecot, *supra* note 3, at 4 (describing circumstances under which localities might ban fracking).

30. *Id.* at 3 (finding that shale-rich New York towns with a higher reliance on private water wells and those with higher livestock water use were associated with a higher probability of adopting a ban during 2010–2013).

31. *Id.* at 5–6 (discussing claims that development boosts state economies, promotes energy security (if homegrown shale gas replaces imported conventional oil), and reduces global greenhouse gas emissions (if shale gas replaces coal)).

about seven percent—or else face widespread bans and other limits that would ultimately prove more expensive.[32]

Under these circumstances, there should be some voluntary self-regulation within the industry. And, in fact, the American Petroleum Institute has developed a set of industry "best practices,"[33] and one organization offers certification to Appalachian Basin operators for compliance with a set of water and air performance standards based on "leading industry practices."[34] But while this type of voluntary self-regulation could account for some of the ordinary risks associated with oil and gas activities, it would likely not account for the uncertain risks associated with fracking or those resulting in harm that manifests later, where causation is difficult to prove.[35]

Against this background, this Article considers the role of government intervention. Whether a tool, or combination of tools, is appropriate depends on the nature of the risk that the government seeks to control or mitigate. To simplify some of the considerations, I categorize the potential harms from shale development into four groups (Categories I, II, III, and IV) broadly based on the timing of pollution discharges and the manifestation of harms. Figure 2 summarizes these risks.

32. Int'l Energy Agency, World Energy Outlook: Golden Rules for a Golden Age of Gas 42, 53 (2012), *available at* http://www.worldenergyoutlook.org/goldenrules/ [https://perma.cc/4CFN-LARW].

33. *Overview of Industry Guidance/Best Practices on Hydraulic Fracturing (HF)*, Am. Petroleum Inst. (2012), *available at* http://www.api.org/~/media/files/policy/exploration/hydraulic_fracturing_infosheet.ashx [https://perma.cc/LAK3-TGPE].

34. *Certification*, Ctr. for Sustainable Shale Dev., http://www.responsibleshaledevelopment.org/what-we-do/certification/ [https://perma.cc/CXW2-MWBS].

35. *See generally* Sidney A. Shapiro & Randy Rabinowitz, *Voluntary Regulatory Compliance in Theory and Practice: The Case of OSHA*, 52 Admin. L. Rev. 97, 99–100, 155 (2000) (discussing incentives that underlie voluntary regulation and concluding it is unlikely to be efficient in most cases).

FIGURE 2

| A Typology of Water-Contamination Harms from Shale Development | | |
|---|---|---|
| Incident Type → Harm Discovery/ Manifestation | Sudden | Gradual |
| Immediate | Category I: Spills, discharges, or blowouts<br><br>Pathways: Some fracturing process (improper well casing); blowouts; some storage/ transport; some wastewater disposal | Category II: Slowly leaking on-site waste storage pits<br><br>Pathways: Some fracturing; storage; some disposal |
| Delayed (latent harms) | Category III: Spills, discharges, or blowouts found to generate latent harms<br><br>Pathways: Fracking fluid flowing into natural fault lines in the local geology; any blowouts, spills or leaks linked to latent health harms | Category IV: Leaking pits, disposal wells, or unplugged abandoned wells that generate later harms<br><br>Pathways: Unplugged abandoned wells with later leaks; later leaking disposal wells; improper wastewater disposal linked to latent health harms; gas seeping into natural fault lines in the local geology |

In this categorization, Category I risks stem from sudden releases, such as accidental spills, discharges, or blowouts that can contaminate nearby soil or water. Category II risks stem from gradual releases, such as slowly leaking on-site wastewater storage pits that can contaminate nearby soil or water. Both Category I and II risks are most likely to occur through surface spills from drilling activities. For example, fracking wastewater is often stored in on-site pits, at least temporarily, and then transported for treatment or injection into a disposal well. Spills could occur when wastewater is transported, or when it is improperly enclosed in storage containers. In fact, leaks and spills often occur at drilling sites, as information on well violations demonstrates.[36] If spills or leaks are not cleaned up, then contaminants might be able to migrate into groundwater sources. These risks to water—from fracking chemical and wastewater spills—were identified by in-

36. In Pennsylvania, the Department of Environmental Protection tracks spills and other violations. Using this information, researchers have identified almost 150 violations for minor spills (spilling less than 40 gallons) and nine violations for major spills in Pennsylvania between January 2008 and August 2011. Timothy J. Considine et al., THE ECONOMIC OPPORTUNITIES OF SHALE ENERGY DEVELOPMENT, CTR. ENERGY POL'Y & ENV'T 9 (2011), https://www.manhattan-institute.org/pdf/eper_09.pdf [https://perma.cc/S8LF-YR4U].

dustry experts and regulators as the most pressing fracking risks,[37] and such spills might already be causing contamination.[38] Under federal law, operators must report qualifying spills of hazardous substances.[39] States, however, are responsible for ensuring that proper regulations are in place to prevent such spills, and these state regulations vary widely.[40] These risks manifest in immediate harms to water sources and are not very different from the water risks presented by all onshore drilling activities, not just shale development.

Category III and IV risks are characterized by uncertain pathways and latent harms. A large proportion of these risks include the uncertain risks of shale development, such as the risk of pollutants moving through fracture systems over the course of years to enter a water source (Category III) or the risk that individuals may develop cancers because of previous exposures to pollution (Category III or IV). These risks are very salient to many, but there has not yet been much evidence to substantiate them. Some of these future harms relate to well completion and abandonment procedures or to wastewater disposal. If adequate procedures are not in place to seal wells, then these wells may develop leaks and gradually discharge pollution over time into the surrounding soil or water (Category IV). Resulting harms are likely to involve property and environmental damage but may also include allegations of adverse health effects, such as cancers caused by long-ago contamination events.

## IV. Evaluating Fracking Risk-Mitigation Systems

Typically, when a socially beneficial activity generates externalities, governments consider several risk-management tools. These were roughly summarized in Figure 1. This Article focuses on three categories of tools that could complement each other to regulate risks to water from shale development: tort, insurance, and regulation. Private parties initiate tort litigation to seek compensation for harms allegedly caused by other parties, thereby also regulating private behavior. But government legislation should clarify the scope of tort liability, and government agencies should issue cost-benefit justified regulations to complement tort liability. Liability insurance is a market tool available to companies to manage risks from their activities. Governments should mandate liability insurance coverage, ensuring that only companies that are able to pay for expected damages engage in an activity. But I argue that such interventions would only adequately address

37. Krupnick et al., *supra* note 9, at 46.
38. *See* Hill & Ma, *supra* note 26, at 522.
39. 42 U.S.C. § 9603(a) (2012).
40. Nathan Richardson, et al., The State of State Shale Gas Regulation, Resources for the Future 1 (June 2013), http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-Rpt-StateofStateRegs_Report.pdf [https://perma.cc/ST4R-2W8A].

Category I and II risks. For other categories of risks, governments should encourage research into uncertain risk pathways. Although others have proposed deploying one or more of these tools to regulate the risks to water of shale development,[41] I argue that effective regulation requires using a combination of these tools to address all risk categories.

## A. *Strengthening Tort Liability*

Tort litigation could manage at least some risks to water from shale development. Tort law considers harms that occur outside of contractual relationships, determining injurer liability and victim compensation. By making injurers pay for harms, a well-functioning tort system would ensure that potential defendants take only those actions in which the benefits exceed the costs, similar to the incentives imposed by a rational regulatory system. Tort law is a good starting point because if an adverse event takes place, successful litigation provides compensation to affected parties. Additionally, litigation might be more efficient than regulation; it does not require government regulators to acquire information on costs and benefits ex ante.[42] Of course, tort litigation is notorious for its limitations in managing environmental externalities.[43] This Section argues that states can increase the effectiveness of the tort system to manage some of the risks to water from shale development through legislation or regulation that would clarify liability, limit judgment-proof operators, and make it easier for plaintiffs to establish causation.

Property owners seeking redress for water contamination from fracking typically bring four common law causes of action: negligence, strict liability for abnormally dangerous activities, private nuisance, and trespass. This Article focuses on the first two causes of action.[44] Generally speaking, in order to establish a defendant's liability, the tort plaintiff must present prima facie evidence showing that (1) the

41. David A. Dana & Hannah J. Wiseman, *A Market Approach to Regulating the Energy Revolution: Assurance Bonds, Insurance, and the Certain and Uncertain Risks of Hydraulic Fracturing*, 99 Iowa L. Rev. 1523, 1528–29 (2014); Thomas W. Merrill & David M. Schizer, *The Shale Oil and Gas Revolution, Hydraulic Fracturing, and Water Contamination: A Regulatory Strategy*, 98 Minn. L. Rev. 145, 197, 245 (2013).

42. Potential defendants, however, must still assess the expected costs of their actions—but it is likely that they possess better information about the harms they might inflict. That said, studies of tort litigation have found it to be inefficient. *See, e.g.*, Joni Hersch & W. Kip Viscusi, *Tort Liability Litigation Costs for Commercial Claims*, 9 Am. L. & Econ. Rev. 330, 330 (2007) (finding that on average the total transaction costs for each dollar received by claimants are $0.75 for all claims and $0.83 for litigated claims).

43. *See, e.g.*, Peter Menell, *The Limitations of Legal Institutions for Addressing Environmental Risks*, 5 J. Econ. Persp. 93 (1991).

44. Trespass cases involving movement of things from the fracking process have generally been denied. *See, e.g.*, Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 4–5 (Tex. 2008). But cases alleging unauthorized horizontal drilling under properties may be more viable.

plaintiff suffered harm and (2) the defendant's activity caused the harm. Courts typically apply one of two liability standards: negligence (the default in many contexts) or strict liability. Under a negligence rule, the plaintiff would additionally need to show that the defendant owed and violated a duty of reasonable care to the plaintiff when engaging in the activity for courts to impose liability on the defendant. In contrast, a strict liability standard imposes liability on defendants for all the harms their actions cause, regardless of whether the defendants are negligent.

Theoretically, either form of liability can result in defendants taking the socially optimal level of care, defined as that which minimizes total social costs after considering the costs of exercising care and the reduction in accident risks.[45] Strict liability, however, would ease the court's decision-making task by removing the comparison of the defendant's level of care to society's optimal level. It might also make sense to hold operators strictly liable for harms because operators may have easier access to insurance to pay for environmental harms that occur even when they take reasonable care. Homeowner policies tend to not cover contamination risks of nearby shale development, but insurers can purchase specialized coverage to cover third-party harms, as discussed in the next Section. Finally, strict liability has the added benefit of discouraging excessive activity levels.[46] Because operators do not pay for resulting harms when they take due care under a negligence rule, they increase their activity levels so long as the benefits of additional activity outweigh their costs of taking due care. Under a strict liability rule, however, operators choose an activity level where their net utility (benefits minus costs of care) is higher than total expected harms, which is the socially optimal level of activity.[47]

Typically, defendants that engage in "abnormally dangerous" or "ultrahazardous" activities are held to a strict liability standard.[48] The Restatement (Second) of Torts lists several factors for courts to consider when determining whether an activity is abnormally dangerous, including the existence of risks and likelihood of harm; the ability to eliminate risks by exercising reasonable care; and the extent to which the activity's value to the community is outweighed by its dangerous

45. Steven Shavell, Foundations of Economic Analysis of Law 181 (2004).

46. *Id.* at 197.

47. If regulations exist, compliance with net beneficial regulatory standards should prevent the assessment of punitive damages against the operator even if compliance does not absolve the operator from liability for harms.

48. *Abnormally Dangerous Activity*, Cornell L. Sch., https://www.law.cornell.edu/wex/abnormally_dangerous_activity (last visited July 8, 2018) [https://perma.cc/S4GM-FABA]; *Ultrahazardous Activity*, Cornell L. Sch., https://www.law.cornell.edu/wex/ultrahazardous_activity (last visited July 8, 2018) [https://perma.cc/H4RQ-TA52].

attributes.[49] So far, only one court—the Middle District of Pennsylvania—has addressed whether fracking is an abnormally dangerous activity that gives rise to strict tort liability for water contamination under state common law.[50] After noting that oil and gas drilling is not generally deemed abnormally dangerous and applying the factors to fracking, the court concluded that fracking, too, is not abnormally dangerous, at least based on the record in that case. Therefore, it held that "traditional negligence principles" would apply to the plaintiffs' claims for property damage and personal injury due to water contamination.[51]

Thus, for strict liability to apply, states would likely have to establish such liability through legislation. This could be similar to what the federal government currently does for sites contaminated with hazardous substances (referred to as Superfund sites) under the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA").[52] Specifically, CERCLA imposes strict liability for contamination by hazardous substances on current operators or owners of sites, past operators or owners, transporters of hazardous substances, and disposal arrangers.[53] To the extent not preempted by CERCLA, states could create similar strict liability systems for shale operators, where any spill of fracking fluid or wastewater could trigger cleanup responsibility.[54] Additionally, states could similarly make more parties potentially responsible for cleanups, thereby producing incentives for other involved parties to monitor the activities of those with whom they choose to work.

Without such state intervention, tort claims would likely continue to fall under the negligence standard, requiring courts to determine the defendant's level of care and calculate the socially optimal level of

49. RESTATEMENT (SECOND) OF TORTS § 520 (1977). The Restatement (Third) of Torts simplifies the conditions for imposing strict liability, focusing on the risk of physical harm even when reasonable care is exercised. *See* RESTATEMENT (THIRD) OF TORTS: PHYSICAL AND EMOTIONAL HARM § 20 (2010).

50. *See* Blake Watson, *Hydraulic Fracturing Tort Litigation Summary*, UNIV. DAYTON SCH. L. (May 22, 2018), https://udayton.edu/directory/law/documents/watson/blake_watson_hydraulic_fracturing_primer.pdf [https://perma.cc/FW42-2YTX].

51. Ely v. Cabot Oil & Gas Corp., 38 F. Supp. 3d 518, 520 (M.D. Pa. 2014).

52. 42 U.S.C. § 9601 (2012).

53. 42 U.S.C. § 9607 (2012).

54. Some fracking-related spills may already trigger CERCLA liability. Fracking fluid contains about 0.5–2% of chemical additives, some of which could be considered hazardous substances. And, if so, a sizeable spill of the fluid on the surface might trigger reporting requirements and emergency response action under CERCLA. But spills of oil and gas do not trigger these requirements because CERCLA exempts oil and natural gas from the definition of a hazardous substance. 42 U.S.C. § 9601(14) (2012). In addition, the purposeful injection of fracking fluids for well stimulation is not federally regulated. In the 2005 Energy Policy Act, Congress amended the definition of "underground injection" under the Safe Drinking Water Act to exclude the injection of fracking fluid in the fracking operation itself, unless the fracking fluid contains diesel. 42 U.S.C. § 300h(d)(1) (2005).

care. Here, too, economics-based government interventions could play a valuable complementary role. If courts apply a negligence rule to drilling operators, a set of net beneficial regulations would ease the court's decision-making task; the court could look to whether the defendant violated relevant regulations.[55]

State regulators should use cost-benefit analysis to inform these regulations, focusing on flexible standards and taking into account local impacts and preferences.[56] Compliance with these regulations would create a presumption that the defendant exercised reasonable care, subject to rebuttal by the plaintiff. To keep calculations tractable, the regulations should focus on avoiding immediate environmental externalities—in other words, those caused by Category I and II risks to water. These risks are known and quantifiable to a large extent based on data from the last decade of shale development, as well as decades of conventional onshore oil and gas drilling. In addition, there are resources available to states to help ensure that their regulations cover most sources of immediate risks.[57] State regulators could also solicit information from industry experts to help calculate costs.[58] Importantly, the regulations should take the form of flexible performance standards to ensure that no specific technology is enshrined in an industry characterized by fast-paced technological innovation and development. The standards might be more stringent in states where the potential benefits of risk mitigation are higher, such as states with more people who rely on private water wells for drinking water.[59] At

55. Merrill and Schizer propose a regulation-and-tort integrated system for managing the risks of shale development. *See* Merrill & Schizer, *supra* note 41, at 239–46. But they urge regulations to adopt best practices based on best-available technologies. But the adoption of such technologies might not maximize net benefits. In addition, technology-based regulations are particularly concerning in a field founded on fast-paced technological innovation.

56. For example, an agency could issue baseline regulations and then condition site-specific permits on additional risk-mitigation practices tailored to local conditions. This is similar to what New York was considering before the state decided to ban shale development. *See Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program*, N.Y. St. Dep't of Envtl. Conservation 21–26 (Sept. 7, 2011), http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf [https://perma.cc/S46F-HS57].

57. The State Review of Oil and Natural Gas Environmental Regulations, Inc. ("STRONGER"), a nonprofit, multi-stakeholder organization with expertise in oil and gas regulations, offers a voluntary review of state oil and gas laws and regulations, including fracking-specific regulations, but so far, only six states have availed themselves of the fracking-specific regulatory review. *Past Reviews*, STRONGER (2018), http://www.strongerinc.org/past-reviews (last visited June 16, 2018) [https://perma.cc/2NNF-PYAY].

58. Concern about regulatory capture that might lead to less-stringent regulations would be mitigated if regulation is supplemented with tort liability that would hold operators responsible for all damages from drilling activities. Comprehensive tort liability will provide incentives that push regulators to adopt cost-effective operating practices.

59. So far, however, researchers have not found many statistically significant associations between observed regulatory heterogeneity and environmental and demo-

the very least, operators should be encouraged to justify their drilling practices with cost-benefit analysis during any litigation; state regulation could ensure that an operator's well-conducted cost-benefit analysis could inform the standard of care.

Clarifying or defining the liability standard could reduce transaction costs associated with tort litigation and promote efficient settlement of claims. But there are several other ways that government intervention could ensure that the tort system acts as an efficient risk-mitigation scheme beyond defining liability standards. First, it could tackle the well-known problem of judgment-proof injurers.[60] These injurers face diminished incentives to mitigate risks because even if disaster ensues and victims sue, the injurers will not be able to pay for damages by compensating the victims and remediating harms. Reports already suggest that smaller operators are, on average, more likely to incur violations during drilling.[61] Regulatory interventions could prohibit judgment-proof drilling operators. Specifically, regulators could require operators to purchase environmental impairment liability insurance coverage for Category I and II risks (covering immediate injury, property, and cleanup costs from both accidental sudden and gradual releases of pollution), as discussed in the next Section. This would guarantee that only operators that are able to pay for expected immediate harms, reasonable care notwithstanding, engage in drilling activities.

Second, it is difficult for plaintiffs to prove that the defendant's actions caused the harm in tort claims involving water contamination from drilling activities.[62] Sudden or gradual pollution spills at drilling sites, for example, can cause contamination of nearby water sources, but contamination can also be naturally present or be due to other human activities, such as the use of pesticides in agriculture. Even if drilling activities cause contamination, multiple operators can contribute to the contamination, making it difficult to hold any one company at fault. Clear rules may provide some relief by creating default liability under certain conditions. For example, states could require operators to provide baseline test results if they want to allege preexisting contamination in a water source. This is essentially the liability rule in Pennsylvania, promoting baseline testing of nearby water wells with-

graphic variables. *See* RICHARDSON ET AL., *supra* note 40, at 16 (suggesting room for improvement).

60. SHAVELL, *supra* note 45, at 233.

61. Daniel Gilbert & Russell Gold, *As Big Drillers Move In, Safety Goes Up*, WALL ST. J. (Apr. 2, 2013), https://www.wsj.com/articles/SB10001424127887324582804578346741120261384 [https://perma.cc/VM3W-22JA].

62. Judith H. Jordan, *Proving Whether or Not Contamination Is Caused by Oil and Gas Operations*, ENVTL. & ENERGY L. SEC. NEWSL. 1 (July 2011), https://www.pabar.org/public/sections/envco/pubs/newsletters/2011-07-25-NewsletterV1E2-Final.pdf [https://perma.cc/H5J6-JEWH]; Keith B. Hall, *Hydraulic Fracturing Contamination Claims: Problems of Proof*, 74 OHIO ST. L.J. FURTHERMORE 71, 73 (2012).

out explicitly requiring baseline testing.[63] As of now, only eight states require operators to test nearby water wells prior to drilling.[64] Texas and Oklahoma, states with significant shale development, have no such requirements.[65] Noncompliance with testing requirements could play a role in determining tort liability as it does in Pennsylvania—that is, operators that fail to test wells prior to drilling could be presumptively liable for any contamination—thereby decreasing some of the difficulties plaintiffs have in proving causation. States could also consider changing the requirements for establishing causation, such as by acknowledging the probabilistic nature of causation in situations involving multiple causal factors.[66]

Although such strategies might reduce some of the difficulty in proving causation, they are unlikely to help plaintiffs that seek to establish causation between latent harms and shale development (Category III and IV risks). Courts may be hesitant to hold operators responsible for contamination or contamination-related harms that are discovered or manifest long after drilling has ceased. The amount of time that has elapsed also increases the likelihood that other factors contributed to the harm. Potential plaintiffs will not have the necessary resources to support scientific research, and judges and juries will not have the expertise to evaluate the research. Proactive research into these risk pathways would support causation for true latent harms that might feature in future tort litigation.[67]

63. Jon Hurdle, *Science Panel Faults EPA Fracking Probe for Excluding Baseline Water Testing*, StateImpact Pa. (Jan. 13, 2016, 6:06 PM), https://stateimpact.npr.org/pennsylvania/2016/01/13/science-panel-faults-epa-fracking-probe-for-excluding-baseline-water-testing/ [https://perma.cc/WWL6-QG48].

64. Richardson et al., *supra* note 40, at 30.

65. *Id.*

66. *See, e.g.*, Glen O. Robinson, *Probabilistic Causation and Compensation for Tortious Risk*, 14 J. Legal Stud. 779, 784 (1985).

67. If states fail to support such research, tort litigation might still play a useful, albeit costly, role in mobilizing research into latent harms. This could arise if future juries award large damages to plaintiffs when there is little scientific evidence to dispute causation. Such occurrences have been documented in previous tort litigation. For example, after a prominent tort case in which the plaintiff alleged latent harms from her silicone breast implants, two jurors indicated after the decision that while they did not think that silicone caused the plaintiff's disease, they awarded her $5.2 million in compensation because she was sick and needed the money and because there was no evidence that silicone was safe. *See* Joni Hersch, *Breast Implants: Regulation, Litigation, and Science*, *in* Regulation through Litigation 142, 142 (W. Kip Viscusi, ed., 2002). Such litigation could even prod the federal government into action. *Id.* (documenting how the FDA had not required implant manufacturers to provide any information on the long-term safety of implants and did not initiate any such studies until after numerous plaintiffs had won multimillion dollar awards through tort litigation). But so far, there has not been such an influx of high jury awards. In the one large jury award for damages relating to fracking-related water contamination in Pennsylvania—where the jury awarded $4.24 million—the district judge vacated the award and ordered a new trial after determining that the evidence was insufficient to support that award. *See e.g.*, Ely v. Cabot Oil & Gas Corp., No. 3:09-CV-2284, 2017 WL 1196510, at *1–2 (M.D. Pa. Mar. 31, 2017).

### B. *Mandating Insurance*

As some scholars have suggested, insurance could also play a role in comprehensive management of risks to water from shale development.[68] Insurance requires companies to pay premiums before any harms occur, thus forcing companies to "save" money in advance to pay for future harms. When clear regulatory standards are in place and when tort liability is well defined, a liability-insurance regime can successfully mitigate environmental risk and ensure that funds are available to compensate victims and remediate the environment.

At first glance, the risk-mitigation benefits of insurance are counterintuitive. Liability insurance is actually a solution to the problem of risk-averse potential injurers either exercising too much care to avoid liability or avoiding the activity altogether when they face strict liability for harms. Both excessive care and suboptimal activity levels reduce social welfare. Therefore, the usual benefit of liability insurance is that injurers could be risk neutral instead of risk averse and generate an optimal (i.e., higher) level of risk. Additionally, purchasing insurance could diminish the insured's incentives for risk reduction, a phenomenon referred to as moral hazard.[69] Essentially, a party (the insured) may take on more risks when another party (the insurer) becomes the one responsible for paying for the consequences of the risks.

Hence, the role of insurance in risk mitigation is not a foregone conclusion. The key conditions for insurers to function as pseudo-risk regulators are their ability to base favorable premiums on the use of sound operating practices and to monitor policyholders to ensure compliance. Scholars disagree about whether insurers monitor compliance,[70] but arguably, if claim payment is conditional on complying with sound practices, and if tort litigation generally reveals the actions taken by the operator prior to an accidental release of pollution, then policyholders would have incentives to adhere to insurance conditions. But, even then, the insurer must base premiums on compliance with some set of operating practices.

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68. Dana & Wiseman, *supra* note 41, 1546–47 (arguing for insurance mandates).

69. Shaila Dewan, *Moral Hazard: A Tempest-Tossed Idea*, N.Y. TIMES (Feb. 25, 2012), https://www.nytimes.com/2012/02/26/business/moral-hazard-as-the-flip-side-of-self-reliance.html [https://perma.cc/PE33-AQM5].

70. Some scholars point to examples where such monitoring occurs and improves outcomes, *see* Omri Ben-Shahar & Kyle D. Logue, *Outsourcing Regulation: How Insurance Reduces Moral Hazard*, 111 MICH. L. REV. 197 (2012), while others argue that insurers' monitoring capacity and history have been overstated, *see* Kenneth S. Abraham, *Catastrophic Oil Spills and the Problem of Insurance*, 64 VAND. L. REV. 1769 (2011). At least one energy insurance provider, Energi, Inc., has revealed to media that its underwriting process does include a compliance audit of a client's operations to ensure that safety and loss-prevention standards are followed. Peter Behr, *Insurance Issues Loom Over Shale Gas Development*, E&E ENERGYWIRE (Aug. 1, 2013), https://www.eenews.net/stories/1059985449 [https://perma.cc/G8VF-S9SQ].

Once again, the existence of cost-benefit-justified regulatory standards could enhance the beneficial properties of insurance. Specifically, premiums could be conditioned on the net-beneficial regulations discussed in the previous Section.[71] This would ensure that the resulting standard of care would continue to be the socially optimal standard of care. This system, however, would generally not work well for Category III and IV risks to water; state cost-benefit-justified regulations are unlikely to address those risks given the uncertainties involved. But, as discussed later in this Section, this gap is not relevant in this context as insurance should not be required to cover latent harms. Finally, an insurance mandate can improve compensation outcomes by barring judgment-proof operators from engaging in drilling.[72] The insurance requirement would need to be set at an optimal coverage amount equal to the expected value of tort harms; otherwise, it might deter too many firms from entering the market.

There are several types of insurance plans available today that can be used to control some of the water-contamination risks of fracking and drilling in general. First, there are traditional commercial general liability ("CGL") policies. These policies provide liability protection for damages from accidental events (including pollution discharges) that occurred during the policy period ("occurrence-based" coverage).[73] Largely due to expanded environmental liability exposure and broad interpretations of the term "accident," CGL policies became stingier over time with their coverage of environmental liability. Basically, environmental liability can attach to injuries or damages that do not manifest until years after the liability-producing accidental pollution release (such as Category III and IV risks to water). The emergence of a "long tail" on claims made it difficult for insurers to predict overall liability.[74] CGL policies began to contain a "pollution exclusion" that precludes liability coverage for damages caused by the discharge of pollution unless the discharge was "sudden and accidental." But because courts have allowed unexpected gradual discharge of pollutants to count as "sudden and accidental" discharges, some CGL

71. Again, if monitoring is an issue, insurers could also condition favorable premiums on maintaining a low record of violations of state regulations, which would achieve similar compliance objectives.

72. Some scholars have argued that the availability of insurance may also improve compensation outcomes by (1) making courts more comfortable with holding companies responsible for the environmental harms caused by their activities, *see generally* Kenneth S. Abraham, The Liability Century: Insurance and Tort Law from the Progressive Era to 9/11 (2008); (2) making injured parties more likely to sue, *see* Dana & Wiseman, *supra* note 41, at 1592; and (3) transferring payment to victims more efficiently, *see* Paul K. Freeman & Howard Kunreuther, Managing Environmental Risk Through Insurance 98–99 (1997).

73. Abraham, *supra* note 72, at 155–70 (describing more thoroughly the emergence and evolution of CGL policies).

74. *Id*. at 152.

policies now contain an "absolute pollution exclusion," which removes the "sudden and accidental" exception.[75]

Instead of standard-form occurrence-based liability coverage for accidental pollution discharges, operators can purchase specialized policies that cover liability and cleanup costs associated with pollution discharges. These policies are generally referred to as environmental impairment liability ("EIL") insurance policies, and there are oil-and-gas-specific EIL policies. These specialized policies cover bodily injury, property damage, and remediation expenses, but they often only provide coverage on a "claims-made" basis, meaning that the policies only cover damages from qualifying pollution events claimed during the policy period. For example, a specialized EIL policy would cover damages from the contamination of a private water well by fracking wastewater that leaked from a storage container located on a well site—if the claim for the loss was made and reported during the policy period. The claims-based coverage cut off the difficult-to-insure long tail, providing no coverage for later liability for long-latency harms from a pollution release that occurred during the policy period.

These policy coverage descriptions suggest that traditional CGL policies are likely to cover Category I and III risks as long as the policies do not contain an absolute pollution exclusion.[76] However, once the CGL policy contains an absolute pollution exclusion, the policy might not cover any water-contamination risks. By contrast, specialized EIL policies are likely to cover Category I and II risks, but they are unlikely to cover any risks with latent harms[77] and any that involve the possibility of delayed detection. Figure 3 summarizes the possible coverage.

75. The stingiest CGL policies include a "total pollution exclusion." IRMI.com, an insurance resource, provides more detailed information about these policies and exclusions. Int'l Risk Mgmt. Inst., http://www.irmi.com (last visited May 30, 2018) [https://perma.cc/LXF5-5F3Y].

76. It is possible, however, that some policies are written to exclude some of the risks of fracking, such as damages stemming from contamination by fracking fluid.

77. Unless insurers are made liable for medical monitoring expenses for potential future manifestations of disease or illness when the claim is made at the time of the accident.

FIGURE 3

| Insurance Coverage for Risk Categories by Insurance Plan | | | | |
|---|---|---|---|---|
| | Category I | Category II | Category III | Category IV |
| CGL | YES | MAYBE | YES | MAYBE |
| CGL with pollution exclusion | YES | NO | YES | NO |
| CGL with absolute pollution exclusion | NO | NO | NO | NO |
| EIL | YES | YES | NO | NO |

*Notes*. CGL refers to commercial general liability insurance plans. EIL refers to environmental impairment liability insurance plans. A "pollution exclusion" precludes liability coverage for damages caused by the discharge of pollution unless the discharge was "sudden and accidental." An "absolute pollution exclusion" removes the "sudden and accidental" exception.

Broadly speaking, insurance is available to cover some water-contamination risks of drilling, especially fracking. Most drilling operators carry CGL policies, but few purchase additional EIL insurance, and those who do may not purchase enough coverage.[78] Of course, an operator could choose not to purchase insurance and self-insure against all environmental risks. When an operator is large enough, self-insurance is a viable strategy. Self-insurance, however, is unlikely to be a viable strategy for small- to medium-sized operators given that damages from water-contamination events are in the millions. Notably, reports suggest that smaller operators are, on average, more likely to incur violations during drilling.[79]

But before mandating any form of liability insurance, state regulators should examine why operators are not purchasing insurance in their area. It could be that operators are not being held liable for immediate environmental harms in tort claims, which could suggest problems in the state's tort-liability regime that should be separately addressed. As discussed in the previous Section, causation hurdles in tort claims make it challenging for plaintiffs to prove their cases—that drilling activities caused their damages. Operators will not choose to pay premiums for coverage that they do not think they will use.

It could also be that operators are not willing to purchase insurance because premiums are too high relative to expected damages. Economists Freeman and Kunreuther document that the ambiguity of risks plays a role when insurers decide what premium to charge—more ambiguous risks lead to higher premiums.[80] One source of risk ambiguity

78. One insurer estimates that only about 30–40% of oil and gas companies buy EIL policies. Douglas Mcleod, *Insurance Coverage Options for Fracking Risks Are Limited*, BUS. INS. (Feb. 24, 2013, 12:00 AM), http://www.businessinsurance.com/article/00010101/NEWS06/302249991/Insurance-coverage-options-for-fracking-risks-are-limited [https://perma.cc/Z9CK-VKE6].

79. Gilbert & Gold, *supra* note 61.

80. *See* FREEMAN & KUNREUTHER, *supra* note 72, at 40–41.

is outstanding liability uncertainty.[81] The liability uncertainty may be highest in the Marcellus shale area because the case law is particularly undeveloped and the extent of damages is high as the area is heavily populated and many people rely on private water wells for drinking water.[82] A few fracking-related water-contamination cases are making their way through the courts, but none have been decided yet.[83] If this is the source of high premiums, state legislators could cut premiums by reducing the tort-liability uncertainty through tort reforms that clarify causation and outline compensable damages. Additionally, the lack of operating practices that maximize the net benefits of shale development could contribute to ambiguity. For example, the senior vice president of Energi, Inc., an energy insurance provider, has called for a "more consistent, visible and effective set of best operating practices" and, in particular, "common agreement among states on a [set of] best practices" to improve insurance availability.[84] Again, here, the development of net beneficial regulations could reduce these concerns.

Finally, the insurance market may not function well on its own due to concerns about adverse selection. Adverse selection occurs when insurers cannot distinguish between operators that present a high risk of loss and those who present a low risk of loss and end up offering both groups insurance coverage at the same price. The riskier operators are more likely to purchase the insurance, which might cause the insurer to raise the price, thus further reducing the probability that less risky firms would purchase insurance. This could lead to a situation where premiums are high, and many operators do not purchase insurance.

Once it is clear that the regulatory and tort systems are able to support the provision and purchase of insurance, states should consider mandating EIL insurance coverage for operators that drill within their jurisdictions. Insurance mandates have two direct benefits: they eliminate adverse selection, and they block judgment-proof injurers from engaging in the activity. Once all firms are required to purchase insurance, the insurer will no longer have to worry about less risky opera-

81. Another source of ambiguity is the scientific uncertainty surrounding some risk pathways. This uncertainty is most prevalent for Category III and IV risks, and I do not advocate that operators should be required to purchase insurance to cover corresponding harms of these risks.

82. This high liability uncertainty may be why only one insurer is known to provide EIL coverage in the Marcellus shale area (Ironshore), and, based on my conversations with insurers, its premiums are expensive.

83. In one exception, the district judge vacated the jury award and ordered a new trial. *See* Ely v. Cabot Oil & Gas Corp., No. 3:09-CV-2284, 2017 WL 1196510, at *1–2 (M.D. Pa. Mar. 31, 2017). Other cases are typically dismissed or settled with nondisclosure agreements. *See* Blake Watson, *Hydraulic Fracturing and Tort Litigation: A Survey of Landowner Lawsuits*, 31 PROB. & PROP. 10, 12 (2017) (providing one exception).

84. Behr, *supra* note 70.

tors opting out. And, if states require the purchase of sufficient coverage, then only operators able to afford to pay out expected damages will remain.

So far, not many jurisdictions require insurance for oil and gas operators.[85] And, when they do, state and local governments vary in the amount of coverage that they mandate and typically only mandate CGL insurance, which could have several pollution exceptions. Operators are required to purchase EIL coverage in only one state, Maryland, which does not yet allow fracking.[86] Maryland requires coverage of at least $1 million to cover bodily injury, property damage, and natural resource damage, which includes the costs of cleanup and remediation caused by the discharge of pollutants.[87] The state also mandates that the insurance be maintained for five years after the well has been sealed and plugged, and the site has been reclaimed.[88]

Under an economic framework, variations in the amount of coverage may be desirable as different areas may have different expected damages from accidental pollution discharges. But, all states should mandate EIL insurance coverage that covers immediate injury, property, and cleanup costs from both accidental sudden and gradual releases of pollution—that is, Category I and II risks to water. Policies should continue to cover only claims made during the policy period, perhaps within some time window of the incident responsible for the pollution release. Policies would then incentivize operators to immediately report spills or leaks to ensure that any resulting damages are covered by their insurance. Early discovery of pollution releases would mitigate environmental damages and minimize remedial costs.

But operators should not be required to purchase insurance coverage that would cover Category III and IV harms.[89] Few insurers would be willing to underwrite such comprehensive policies given the uncertainty associated with latent harms, and the inclusion of these harms in coverage would drive up premiums. Professors Dana and Wiseman, who first discussed the valuable role insurance mandates could play in the fracking context, disagree; they argue that "insurance markets have consistently produced adequate insurance capacity once a mandate was enacted" despite risk uncertainty and predictions to the con-

85. Municipalities such as Arlington, Texas and Fort Worth, Texas, and some states, including Colorado, Idaho, Maryland, New Jersey, Ohio, and Oregon, require insurance coverage. For a more comprehensive overview of local and state efforts, see Dana & Wiseman, *supra* note 41, at 1531–32.

86. MD. CODE ANN., Envir. § 14-111(a)(7) (West 2013).

87. *Id.*

88. *Id.* § 14-111(b)(1)–(2).

89. An exception to this is the previously discussed requirement for operators to post assurance bonds to ensure proper well abandonment. *See* Dana & Wiseman, *supra* note 41, at 1562, 1593. Once the operator proves that it has properly plugged and sealed the well, the operator may retrieve the bond that it posted.

trary.[90] But previous cases where insurers supplied enough insurance capacity to satisfy demand despite uncertain environmental liability were characterized by significant tort and regulatory reforms, particularly damage caps.[91] These caps made it easier for insurers to price premiums for uncertain risk pathways.[92] Unless state legislatures set liability caps for damages from accidental pollution releases, then it is unlikely that many insurers will offer to insure operators against liability for later-manifested harms.

### C. *Plugging Gaps with Regulation*

So far, this Article highlights several possible roles for government intervention to support the already existing risk-mitigation systems: clarifying liability standards, providing cost-benefit justified regulatory standards, and mandating insurance. In particular, the Article argues that these regulations can work together to promote comprehensive management of Category I and II risks.

Some Category IV risks might also be amenable to cost-benefit justified regulation. Specifically, for Category IV risks such as future leaks in disposal wells or improperly plugged abandoned wells,[93] regulators could require companies to post assurance bonds at well completion.[94] Once the operator proves that it has implemented cost-effective features to ensure that the wells are unlikely to leak, the operator may retrieve the bond that it posted. The bond would thus counteract the incentive for companies to simply abandon or improperly seal wells once drilling or disposal is complete.

Generally speaking, however, it would be difficult for regulators to assess the benefits and costs of risk-mitigation strategies to manage Category III risks and some Category IV risks, specifically those that manifest in the future through highly uncertain pathways. Because harms are yet to manifest (if they manifest at all), the calculation of

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90. *Id.* at 1573.

91. To support their claims, Dana and Wiseman refer to the $1.5 billion in insurance capacity generated in response to a de facto insurance mandate on offshore oil shippers and drilling operators. *Id.* at 1574. But, the federal liability scheme for offshore drilling, *see generally* 33 U.S.C. § 1321 (2012); 33 U.S.C. §§ 2701–61 (2012), imposes a maximum liability cap that depends on the facility, typically removal costs plus $75 million, *see* 33 U.S.C. § 2704(a) (2012) (which applies to offshore facilities, excluding deepwater ports). Of course, as the 2010 BP *Deepwater Horizon* disaster demonstrated, these insurance limits can be far too low to compensate victims and remediate the environment in the case of large spills. I discuss the possibility of catastrophic damages in the next Section.

92. For example, the federal government has mandated insurance for owners of nuclear plants *with* limited private liability. NUCLEAR INSURANCE AND DISASTER RELIEF, U.S. NUCLEAR REG. COMM'N (2018), https://www.nrc.gov/docs/ML0327/ML032730606.pdf [https://perma.cc/JJ2E-VKDC] [hereinafter NRC FACT SHEET].

93. These harms do not manifest later, but rather, they may actually occur later if proper precautions are not taken in advance.

94. *See* Dana & Wiseman, *supra* note 41, at 1526–27 (proposing this solution).

benefits of specialized risk-mitigation strategies would be a speculative venture. Command-and-control regulations, the most common form of state regulations,[95] are particularly unlikely to provide the flexibility necessary for regulators to adapt to new information on these risks and the magnitude of harms. Such inflexible regulations could also hinder technological innovation, which is key to the success of the oil and gas industry.

In these circumstances, regulators generally have two options: err on the side of caution and either prohibit or significantly reduce the extent of shale development with stringent regulation; or regulate known risks with cost-benefit justified regulations now and learn about the uncertain risks as development unfolds. The first option is embodied in the precautionary principle, which states that those wanting to take an action bear the burden of proving that the action does not create a risk of harm to the public or the environment. This principle is often thought to be too strong, prohibiting many net-beneficial actions. In the context of shale development, at least based on the currently available information, the second option is preferable.[96]

The second option is only reasonable, however, if researchers actively monitor and investigate the uncertain Category III and IV risks to water. Operators likely will not have adequate incentives to investigate the nature of uncertain pathways and latent harms. By definition, these harms manifest later, so operators would have to anticipate future tort liability to invest in this research now.[97] Tort litigation could help though—as cases enter the system, large judgments against operators may mobilize research.[98] But in the short term, the government would have to either incentivize research or conduct its own research into latent harms and uncertain pathways in order to respond appropriately as soon as information is available.

These tasks would be most efficiently accomplished at the federal level to avoid repetition and to take advantage of considerable re-

95. Currently, more than 80% of state regulations are command-and-control regulations, and about 1% are flexible performance standards. *See* RICHARDSON ET AL., *supra* note 40, at 14. The rest rely on case-by-case permitting and other methods. *Id.*

96. There are circumstances, however, where caution is ideal. For example, Arrow and Fisher find that it might be optimal to err on the side of underdevelopment of a resource if development of the resource would cause irreversible environmental harm or if preservation of the resource is likely to have a high value in the future. *See* Kenneth J. Arrow & Anthony C. Fisher, *Environmental Preservation, Uncertainty, and Irreversibility*, 88 Q.J. ECON. 312, 313–14 (1974). In the case of contamination risks to water from shale development, current evidence does not suggest that contamination would be irreversible, though it might be costly to clean up contaminated water sources.

97. Some tort plaintiffs alleging immediate harms from adverse well events are also calling for medical monitoring costs and, if successful, might later hold operators responsible for latent health harms. For example, see Strudley v. Antero Res. Corp., 350 P.3d 874 (Colo. App. 2013).

98. *See* Hersch, *supra* note 67.

sources, but if an enhanced federal role is unlikely at this time, then states could take up this research role. For example, the government could require operators to invest a certain amount into research conducted by neutral scientific or research bodies. The government could also use taxes on the oil and gas industry to pay for the costs of conducting this research itself. Research could range from passive health monitoring of specific populations exposed to a major pollution event to active testing of uncertain risk pathways. For example, the U.S. Department of Energy injected fracking fluid with tracer chemicals into a drilling site in order to monitor the process of the fluid over several years.[99] Similar projects could occur at different shale formations and provide useful information to regulators, the public, and courts. When given the appropriate weight, the information could help set future regulatory standards and verify causation in tort. If governments are concerned about having money available to address these latent harms in the future, then they could apply a portion of regulatory fines to form a fund. This fund could be used in the future to remediate the environment and compensate victims when those responsible for latent-manifesting contamination are unable to pay.[100] Financing the fund with a percentage of fines collected each year would also add a fault element; those responsible for the worst violations would contribute a larger amount of money to the fund.

Finally, managing the possibility of catastrophic damages from shale development would require even more specialized attention. If a low-probability risk of catastrophic damages manifests, the injurer is unlikely to have the financial resources to pay for damages, even in a regulatory system that requires operators to carry insurance that would cover expected damages. Current research has not found shale development to be associated with such risks.[101] But states concerned about low-probability catastrophic damages of shale development could look to the proposals for creating a system to cover catastrophic damages from offshore drilling accidents. Many of these proposals were generated in the wake of the 2010 BP *Deepwater Horizon* disaster that highlighted the inadequacy of the regulatory regime for offshore drilling in dealing with spills of that magnitude. Insights from these proposals could be applied to onshore shale development.[102]

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99. Kevin Begos, *DOE Study: Fracking Chemicals Didn't Taint Water,* USA TODAY (July 19, 2013, 10:23 AM), https://www.usatoday.com/story/money/business/2013/07/19/doe-study-fracking-didnt-taint/2567721/ [https://perma.cc/XY6D-QLWD].

100. Ideally, health insurance would cover latent health risks to individuals.

101. That is not to say that such risks are impossible, especially through some of the uncertain risk pathways.

102. For several proposals detailing schemes that would cover damages from offshore drilling accidents generated in the wake of the 2010 BP *Deepwater Horizon* disaster, see W. Kip Viscusi & Richard J. Zeckhauser, *Deterring and Compensating Oil-Spill Catastrophes: The Need for Strict and Two-Tier Liability*, 64 VAND. L. REV. 1717, 1722–25 (2011); Mark A. Cohen et al., *Deepwater Drilling: Law, Policy, and Economics of Firm Organization and Safety*, 64 VAND. L. REV. 1853, 1857 (2011). Of

## V. Conclusion

The fracking context is characterized by a variety of risks, some known and some unknown. States, responsible for managing these risks, have generally adopted one of two responses: (1) conducting business-as-usual and employing the same regulations for shale development as for conventional drilling; or (2) banning (or allowing localities to ban) fracking altogether. Few states have evaluated the new challenges associated with shale development and updated their regulations accordingly.[103]

Additional government intervention should not be undertaken lightly, especially in an industry characterized by fast-paced innovation and technological change. But if adequate attention is placed on risks, incentives, and cost-benefit analysis, then it is possible for government regulation to supplement market-based or voluntary risk-mitigation systems to improve aggregate welfare. This Article applies these principles to regulating shale development. It highlights how tort, insurance, and regulatory systems interact with each other and identifies risk-mitigation gaps that governments could address. Below, Figure 4 summarizes the tools that regulators should prioritize for each risk category.

Figure 4

**Prioritizing Regulatory Tools by Risk Category**

| | Category I | Category II | Category III | Category IV |
|---|---|---|---|---|
| Net-Beneficial Regulation | YES | YES | NO | Some: YES |
| Research Investments | NO | NO | YES | YES |
| Tort Liability Standards | YES | YES | YES | YES |
| Insurance Mandates (EIL) | YES | YES | NO | NO |
| Assurance Bonds | NO | NO | YES | YES |

*Notes*. EIL refers to environmental impairment liability insurance plans. See text for details.

Category I and II risks manifest in immediate harms to water sources. These risks are not very different from the risks to water

course, in the case of fracking, the worst-case scenario damages would be different than those for offshore drilling, and these damages could vary by shale formation. States could also require all operators to maintain separate, additional insurance coverage that would be activated should any operator cause catastrophic damages above an individual liability cap. For example, claims resulting from nuclear accidents are covered under the Price-Anderson Act, which mandates an individual "first tier" level of insurance for owners of nuclear power plants and generates a plan for obtaining additional funds from insurers in the case of severe accidents. NRC Fact Sheet, *supra* note 92.

103. Exceptions might include Pennsylvania and New York, before its ban, at least to some extent.

presented by all onshore drilling activities, not just shale development. Regulators should require operators to adopt all risk-mitigating operating practices that generate net benefits. Strict liability for drilling harms will also motivate operators to adopt these practices, especially if legislative and regulatory interventions facilitate recovery for actual drilling-related harms. Mandatory insurance coverage for Category I and II risks will then guarantee that only operators that are able to pay for expected immediate harms (reasonable care notwithstanding) engage in drilling activities. Net beneficial regulations, an adequate enforcement system, and robust tort litigation will ensure that operators continue to adopt all net-beneficial risk mitigation operating practices.

States should recognize that such strategies, however, are unlikely to address those Category III and IV risks that are characterized by uncertain pathways and latent harms. Regulators should encourage research now to learn more about these risks. By being proactive, regulators can amass scientific data and update regulations in a timely manner and in an appropriate way given the information. Tort litigation would still function as a backstop motivating force.

By applying principles of risk, incentives, and cost-benefit analysis, state governments can facilitate responsible shale development by creating incentives for optimal activity levels, acceptable risk-taking, and comprehensive environmental protection. In general, these principles will ensure that regulators identify combinations of tools that effectively achieve environmental goals.