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Articles

Fracking as a Test of the Demsetz Property Rights Thesis

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Since its introduction in 1967, the account of property rights formation by Harold Demsetz has pervaded the legal and economic literature. Demsetz theorized that as a once-abundant, commonly shared resource becomes more valuable and sought-after, users will move to more clearly define property rights in the resource. Despite the high transaction costs of this approach, the costs of organizing and enforcing a rights regime become worthwhile in the face of scarcity. And privatization, in turn, leads to more efficient use of the resource by the individuals holding the property rights, with less externalization of the harmful effects of resource use. Modified accounts provide a more nuanced story in which "governance"—broadly speaking—emerges to address scarcity concerns. This governance can include traditional regulation that draws clearer property rights in the resource and forces cost internalization as well as innovative, less formal regimes, such as monitoring and reporting of resource use, voluntary agreements to internalize certain harms, and other commons management tools. But a conundrum remains: in some cases, scarcity does not generate regulation or innovative governance, and legal scholarship has called for more empirical testing of the reasons for this anti-Demsetzian response.

Hydraulic fracturing, or "fracking," presents a perfect case study for this sort of test. This oil and gas extraction technique, which has recently boomed in the United States, has identifiable and substantial negative externalities including, for example, air pollution and over-withdrawals of freshwater during droughts. Yet states and industry actors have not consistently responded with regulations or innovative governance strategies to internalize these externalities. In this Article, we explore the responses of three states experiencing a fracking boom and theorize the reasons for the diverse responses of these states to greater fracking externalities, including responses that do not track the Demsetz theory. We conclude that traditional political explanations, often pejoratively referred to as "capture" or "rent-seeking," political culture, and legal institutions—particularly courts—account for the divergence between what we observe empirically and what Demestz's theory would predict.

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INTRODUCTION

Harold Demsetz's 1967 article on the origins of property rights is a classic in both economics and law.[1] Yet, while Demsetz's article has received and continues to receive significant academic attention, Demsetz's theory has not been scrutinized extensively as an empirical matter.[2] Demsetz told a simple story in his famous article. Consider, for example, cattle as a resource. As cattle become more valuable, there are greater returns on raising them, and thus more are raised. One possible externality of raising more cattle in an open-fields regime—grazing to the point of depletion—increases. Once the benefits of eliminating that depletion externality now exceed the costs of re-ordering the rights regime, the rights regime is reconfigured such that fields are now enclosed as private property. Legal exclusion will now temper or prevent depletion.

As Henry Smith has noted, the Demsetz thesis never accounts for the historical facts that commons facing depletion threats sometimes were enclosed, but by the same token enclosed areas sometimes were transformed into semicommons.[3] In a semicommons, some parts of the resource, such as partial strips of land in a field, remain as shared commons, and other parts are enclosed.[4] Moreover, threats of depletion sometimes result in semi-commons not being enclosed but being subject to more refined and protective resource rules applicable to all users—what Smith calls governance, as opposed to exclusion.[5] Smith agrees that changes in economics or technology that make a resource more valuable, and hence increase externalities, result in innovation. But he argues that, depending on the context, that innovation can look like new Blackstonian private property (exclusion), new collective regulation (governance), or something in between.[6]

Following Smith, it is possible to reformulate the Demsetz thesis in a way that is less biased toward exclusion outcomes, more intuitive, and more likely to fit the realities of resource use and management. In particular, and again borrowing on Smith's framework, we reformulate the Demsetz thesis as embodying two related propositions:

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1. Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 354–59 (1967). The Demsetz article features prominently in leading Property casebooks. *See, e.g.*, JESSE DUKEMINIER ET AL., PROPERTY, 32–34 (9th ed. 2018); THOMAS W. MERRILL & HENRY E. SMITH, PROPERTY: PRINCIPLES AND POLICIES, 239–45 (3d ed. 2016).

2. Some case studies in other contexts have begun to provide empirical tests of the theory. *See, e.g.*, Gary D. Libecap & James L. Smith, *The Economic Evolution of Petroleum Property Rights in the United States*, 31 J. LEGAL. STUD. S589 (2002); Dean Lueck, *The Extermination and Conservation of the American Bison*, 31 J. LEGAL STUD. S609 (2002).

3. Henry E. Smith, *Semicommon Property Rights and Scattering in the Open Fields*, 29 J. LEGAL STUD. 131, 143 (2000) (observing that Demsetz's example of property rights developing in the beaver fur industry as demand for fur increased is actually an example of a semicommons).

4. *Id.* at 148.

5. Henry E. Smith, *Governing the Tele-Semicommons*, 22 YALE J. ON REG. 289, 294 (2005); Henry E. Smith, *Property and Property Rules*, 79 N.Y.U. L. Rev. 1719, 1755–56 (2004).

6. Henry E. Smith, *Exclusion Versus Governance: Two Strategies for Delineating Property Rights*, 31 J. LEGAL STUD. S453, S474–84 (2002).

> (1) Specification: With the spike in resource use, and hence externalities, there will be a different or greater specification of resource users' rights and obligations. That specification often will take the form of a change in the legal regime (e.g., laws requiring or encouraging enclosure). It can also involve "softer" governance strategies, such as commons governance tools noted by Elinor Ostrom, including monitoring of user behavior, voluntary agreements among resource users or between communities and resource users, and similar mechanisms.[7]
>
> (2) Cost Internalization: The new or greater specification will encourage greater internalization of the social costs associated with the resource use.

Ambiguities regarding rights and obligations that are tolerable when there is no great demand for a resource and minimal externalities associated with its use become intolerable in the face of high demand and potentially large externalities. In Demsetz's example, when there is limited demand for cattle, there may be no need for a specification as to exactly where or for how long a particular group's cattle may graze. But that is no longer true once new market opportunities create a widespread rush to raise as many cattle as possible. At that point, greater specification is needed, whether in the form of clearer boundaries and/or clearer use rules for the commons. This greater specification will foster cost internalization, thus addressing the problem that spurred the innovation in the first place. Thus, whether increased demand for cattle leads to clearer boundaries around private land or new use regulation for a semi-commons, we would anticipate that the innovation will operate so as to temper the risk of overgrazing.

At a very minimum, when demand for a resource spikes, one might expect to see innovation in the form of better definition of: (a) the resource, and (b) the extent of resource use actually made of by each actor in the relevant geographical area. As Ostrom's principles of design for resource management suggest, tracking and monitoring of resource use is a key feature of any management regime that does not rely on a pure-exclusion strategy for addressing externalities—a strategy that sometimes may be simply impossible, depending on the physical context.[8]

As Tom Merrill has suggested, one approach to exploring what we call the reformulated Demsetz thesis would be to identify situations where, despite an increase in resource use and externalities, there has been no innovation in either exclusion or governance.[9] One possible explanation for this lack of innovation could be that the total costs of innovation exceed the total benefits; in this scenario, as is entirely consistent with Demsetz's classical economic approach, no innovation would be rational, efficient and unsurprising. But there are other reasons we might observe no innovation. Political power—often pejoratively

7. ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 90 (2018).

8. *See id.*

9. Thomas W. Merrill, *Introduction: The Demsetz Thesis and the Evolution of Property Rights*, 31 J. LEGAL STUD. S331, S338 (2002).

referred to as capture or rent-seeking—might prevent innovations that would be "efficient" in a Demsetzian sense but would not be to the benefit of one of more politically powerful groups.[10] Institutional economics, especially the Ostrom school of economics, which conceives of resource management as a deeply contextual matter, would suggest that there can be many reasons for the absence of innovation—politics, culture, and history (path dependence), among them.[11]

Hydraulic fracturing, or "fracking,"[12] provides an excellent context for exploring the reformulated Demsetzian thesis. Slick water fracking—the most common modern form of fracking, now applied to most wells—is a form of oil and gas extraction made possible by recent technological innovation.[13] That innovation, in turn, made land rights and mineral rights much more valuable than had previously been the case, as oil and gas wells could be profitably established in areas and on sites where they never would have been located in the absence of the new technology.[14] With greater extraction of the oil and gas resource, however, has come an increase in externalities—in costs that the fracking entity, like the cattle owner in an open-grazing field, does not itself necessarily bear, at least in the very near term. These three externalities we label as the water supply externality, the water quality externality, and the neighborhood amenity externality, which refers to localized impacts such as noise, aesthetic effects, and dust.[15] Following the reformulated Demsetz thesis, one might suppose that, given the scale of the fracking "revolution" in energy production and its external effects and risks, that revolution would be accompanied by innovation. The innovation would more clearly specify fracking entities' rights and obligations, and in a way that would address water supply, water quality, and neighborhood amenity concerns.

We see such innovation in some of the jurisdictions with fracking, and thus we find some support for the Demsetz thesis, but we also see support for the conclusion that it may lack explanatory power in some contexts. Taken together, our three case studies—fracking in Pennsylvania, Colorado, and Texas—

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10. *See, e.g.*, Herbert Hovenkamp, *Appraising the Progressive State*, 102 IOWA L. REV. 1063, 1094 (2017) ("Writers about entitlements or regulation often speak of capture as 'rent-seeking.'"); Michael A. Livermore & Richard L. Revesz, *Regulatory Review, Capture, and Agency Inaction*, 101 GEO. L.J. 1337, 1340 (2013) ("Capture describes situations where organized interest groups successfully act to vindicate their goals through government policy at the expense of the public interest.").

11. *See* OSTROM, *supra* note 7.

12. For a discussion of this terminology, see John M. Golden & Hannah J. Wiseman, *The Fracking Revolution: Shale Gas as a Case Study in Innovation Policy*, 64 EMORY L.J. 955, 957 n.1 (2015).

13. For detailed discussion of the multiple technological innovations that merged to allow widespread fracking in the United States by the late 2000s, see *id.* at 968–74.

14. *See id.* at 1000–01 (noting how George Mitchell—a fracking pioneer—invested in low-value land and mineral rights that later increased substantially in value due to fracking innovation).

15. Another way of formulating the effects of fracking is to conceive of it as raising tensions between the private, non-collective property right in oil and gas extraction, and the sometimes private—and sometimes collective—property rights in water supply, water quality, and the amenity of an urban or suburban neighborhood that is free from the aesthetic and psychological harms and perceived physical risks of encroaching oil and gas wells. *See generally* Lee Anne Fennell, *Ostrom's Law: Property Rights in the Commons*, 5 INT'L J. COMMONS 9 (2011) (describing collective neighborhood rights).

suggest that raw political power, cultural and legal traditions, and even the happenstance of the composition of a court can lead either to a Demsetzian outcome or one that strays from such an outcome. These various factors can facilitate a greater specification of rights and obligations in response to new technology and hence new resource demands and greater externalities, or they can effectively block any such specification. Context, above all, is what matters. Thus, even in its reformulated version, the Demsetz thesis, while providing an analytically appealing frame for analysis, does not necessarily tell us what will happen when there is increased demand for a limited resource.

To further explore the Demsetz thesis through a fracking lens, this Article begins in Part I by documenting the externalities of fracking. To Demsetz, externalities were inseparable from property because property rights confer the right to "benefit or harm oneself or others," such as selling a superior product to a competitor.[16] An externality arises when the cost of internalizing the benefit or harm associated with the property right—in other words, causing one of the entities in the property relationship to bear the effects of the harm or benefit—are too high to make voluntary internalization worthwhile.[17] Changing the nature of the property right by placing more legal barriers on acquisition of the right, such as requiring a permit to frack a well, forces internalization.

Part II explores responses to a boom in fracking activity in three states with divergent geographies and political cultures—Texas, Colorado, and Pennsylvania. This Part explores the extent to which greater negative externalities of oil and gas development generated a Demsetzian response, triggering enhanced exclusion in the form of greater specification of property rights or, alternatively or additionally, new governance. Part III then draws lessons from these case studies, exploring how they add to debates about the nature of property rights and the extent to which the Demsetz theory holds up when tested empirically. It demonstrates the emergence, in some cases, of Ostrom-type governance innovations as well as more traditional regulatory responses. And in other cases, the study shows a lack of innovation due to politics, institutional path dependence, and other factors.

We conclude by emphasizing the need for further study of the variability of responses to similar resource demands, both in terms of the extent and substance of any innovation. The fracking case study matches the modern, more refined form of the Demsetz theory—a form enhanced by more nuanced legal and economic theories that augment the original account. But it also highlights, in some cases, the substantial deviation from the property rights innovation framework that dominates the current academic literature and the relatively sparse theory to explain this deviation.

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16. Demsetz, *supra* note 1, at 347.
17. *Id.* at 347–48.

I. FRACKING AND ITS EXTERNALITIES

Slick water hydraulic fracturing for shale oil and gas, combined with horizontal drilling, represents a technological innovation that has transformed energy production in the United States (and elsewhere). In just a matter of years, U.S. annual oil production increased from more than 154 million barrels in 2005 to more than 309 million barrels in 2017.[18] During this same time period, annual domestic natural gas production rose from more than 1.5 trillion cubic feet to nearly 2.4 trillion cubic feet.[19] The number of estimated fracked wells has skyrocketed, from 26,000 in 2000 to approximately 300,000 in 2015.[20] Moreover, there are active "plays" being fracked throughout the United States, and, where it is pursued, fracking is by no means limited to remote rural areas. Wells have been drilled very close to (and indeed in the midst of) exurban, suburban, and even urban population centers.[21] In this respect, fracking has a geographic footprint unlike conventional oil and gas drilling or coal mining.[22] In several parts of the United States, it is possible to gaze out a school building window or the window of a single-family home in an urban or suburban development and see a fracked well.[23]

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18. *Petroleum & Other Liquids*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS1&f=M (last updated Mar. 31, 2020).

19. *Natural Gas*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/dnav/ng/hist/n9070us2m.htm (last updated Mar. 31, 2020).

20. *Hydraulically Fractured Wells Provide Two-Thirds of U.S. Natural Gas Production*, U.S. ENERGY INFO. ADMIN. (May 5, 2016), https://www.eia.gov/todayinenergy/detail.php?id=26112; *Hydraulic Fracturing Accounts for About Half of Current U.S. Crude Oil Production*, U.S. ENERGY INFO. ADMIN. (Mar. 15, 2016), https://www.eia.gov/todayinenergy/detail.php?id=25372.

21. *See City of Fort Worth Gas Well Status February 2018*, https://fortworthtexas.gov/developmentservices/gaswells/gas-well-map.pdf?v=2 (last visited Apr. 15, 2020) (showing 1980 producing natural gas wells within Fort Worth city limits).

22. Individually, fracked well sites are not always larger than conventional well sites. But fracking has enabled the drilling of thousands of wells that otherwise would not have been developed; with dwindling conventional supplies, oil and gas development in the United States would not have otherwise boomed. Further, multi-well sites with horizontally drilled wells are common for horizontally drilled and fracked wells. Horizontal drilling reduces the number of well sites needed, but multi-well sites mean that individual fracked well sites are larger. *See* NELS JOHNSON ET AL., PENNSYLVANIA ENERGY IMPACTS ASSESSMENT REPORT 1: MARCELLUS SHALE NATURAL GAS AND WIND 13 (2010), https://www.nature.org/media/pa/tnc_energy_analysis.pdf (describing multi-well pads); *see also* Michael Focazio, *Geographic Footprint of Shale Gas Extraction*, *in* HEALTH IMPACT ASSESSMENT OF SHALE GAS EXTRACTION: WORKSHOP SUMMARY 17, 25 (2014) (noting on-site and off-site land impacts, including, for example, sand mining for proppant used in fracking). *But see Footprint Reduction*, U.S. DEP'T OF ENERGY, https://www.energy.gov/sites/prod/files/2016/07/f33/Footprint%20Reduction.pdf (last visited Apr. 15, 2020) (noting applied research that has helped to reduce unconventional well footprints).

23. *See* Sci. Advisory Bd. Hydraulic Fracturing Research Advisory Panel, U.S. Envtl. Prot. Agency, Summary Meeting Minutes 13, https://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/4EF0513AF548B70385257F17006EB070/$File/Minutes-HF+February+1+teleconference-Final.pdf (last visited Apr. 15, 2020) (providing a resident's statement regarding a well 500 feet from the front door of his home); Julie Turkewitz, *In Colorado, a Fracking Boom and a Population Explosion Collide*, N.Y. TIMES (May 31, 2018), https://www.nytimes.com/2018/05/31/us/colorado-fracking-debates.html (noting a well that would soon be developed behind a school); Hannah J. Wiseman, *Urban Energy*, 40 FORDHAM URB. L.J. 1793, 1811 (2016) (noting a man's testimony about the impacts of a well in his backyard).

Because of the process of drilling, fracking, and waste disposal, the intensity with which it is being pursued, and its reach into highly populated areas, fracking generates substantial "externalities"—costs that, unless incentivized or required to do so, the companies that engage in and profit from fracking will not internalize. There have of course been substantial positive externalities from the boom,[24] but on the negative side of the ledger, some of the externalities from fracking are realized as harm or costs by others. The noise from trucks servicing fracking wells, for example, is a harm to neighbors inasmuch as it affects their sense of tranquility and quality of life.[25] Other externalities take the form of the imposition of risk of harm. For example, as discussed below, fracking creates a risk of water contamination, which in turn creates a risk of health and economic harms associated with contaminated drinking water.[26] Even the most ardent foes of fracking would not claim that fracking in a given area is assured to contaminate groundwater and hence contaminate drinking water. Indeed, surface water contamination appears to have been far more common, and groundwater pollution incidents have been rare.[27] But bearing the risk of contamination—even when the risk, although grounded in fact, is not reasonably quantifiable or subject to a wide range of plausible quantitative estimates—is an externality in itself.[28]

Moreover, an externality, in its physical dimension, can be doubly impactful because it may include both aspects of immediately realized harm or costs and, at the same time, a risk of future harm or costs. Consider, for example, air pollution associated with the process of fracking wells. The air pollutants

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24. *See* 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, 157 (2013) (noting large economic benefits).

25. *See* MD. DEPT. OF THE ENV'T, MARCELLUS SHALE RISK ASSESSMENT, app. F at 6 (2015), https://mde.state.md.us/programs/LAND/mining/marcellus/Documents/Appendix_F-Noise_and_Visual_Risks.pdf.

26. The greater risk of contamination appears to be from spills of fracturing chemicals and flowback at the surface, which can seep through impermeable soil. There have also been rare instances of underground fracked wells themselves causing contamination. U.S. ENVTL. PROTECTION AGENCY, HYDRAULIC FRACTURING FOR OIL AND GAS: IMPACTS FROM THE HYDRAULIC FRACTURING WATER CYCLE ON DRINKING WATER RESOURCES IN THE UNITED STATES 6-1 (2016), https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990.

27. *See id.* at 6-1, 5-59 (noting that the EPA "identified two cases where hydraulic fracturing activities affected the quality of drinking water resources due to well construction issues, including inadequate cement or ruptured casing" and other cases in which methane migrated from wells with casing problems); *see also id.* at 5-50 (noting other cases of surface water contamination and groundwater contamination from surface spills that likely seeped through soil intro groundwater sources).

28. Regarding quantitative estimates of the risk of groundwater pollution from drilling or fracking, one way to estimate the risk of contamination is to examine the frequency with which the casing (lining) of wells fails after drilling or fracking a well. One study estimates that unconventional (fracked) wells in Pennsylvania are 2.7 times more likely to fail than are conventional wells and that between 2000–2012, 6.2% of unconventional wells exhibited a loss of structural integrity of their casing. Anthony R. Ingraffea et al., *Assessment and Risk Analysis of Casing and Cement Impairment in Oil and Gas Wells in Pennsylvania, 2000–2012*, 111 PROC. NAT'L ACAD. SCIENCES 10955, 10956 (2014). Other studies that have used the same data set found lower failure rates. R.D. Vidic et al., *Impact of Shale Gas Development on Regional Water Quality*, 340 SCI. 1235009-1, 1235009-4 fig.2 (2013) (estimating 3.4% leakage from unconventional wells).

may cause immediate harm, in the form of smog that reduces the aesthetic appeal of an area and results in respiratory irritation. But the air pollution also may impose the risk of greater harms of, for example, respiratory disease, which may not manifest until years after exposure.[29]

Fracking produces many externalities, which vary depending on where and how fracking is undertaken, and these externalities can be described in a range of ways. We focus on three categories of externalities that we view as driving much of the current social and political controversy surrounding fracking—water supply, water quality, and (what we call) "neighborhood quality." As we discuss below, with respect to each of these kind of externalities, there is a general societal consensus—embodied in the law of property, environmental regulation and local zoning—that these kinds of externalities are the sort that *generally* should "count" in assessing social welfare.[30] Moreover, although the nature and extent of these three kinds of externalities varies from place to place, they are all substantially at issue in our three case study states of Texas, Pennsylvania, and Colorado. We address each in turn.

A. WATER SUPPLY AND QUALITY

The type of fracking that has unlocked vast reserves of oil and gas from shales is called "slick water" fracking, and it requires large quantities of water.[31] As operators have perfected fracking in shales around the United States, water use per well has increased over time in most regions.[32] The quantity of water used varies depending on whether the well is vertically drilled or drilled

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29. *See* ALAMO AREA COUNCIL OF GOVTS., OIL AND GAS EMISSION INVENTORY, EAGLE FORD SHALE, TECHNICAL REPORT 9-1 (2014), https://www.documentcloud.org/documents/1109217-aacog-oil-%20and-gas-emission-inventory-april-4-2014.html (noting that in Texas's Eagle Ford shale region—host to many fracked wells—production "emitted 66 tons of NO_X and 101 tons of VOC per ozone season day in 2011"); Peter M. Rabinowitz et al., *Proximity to Natural Gas Wells and Reported Health Status: Results of a Household Survey in Washington County, Pennsylvania*, 123 ENVTL. HEALTH PERSP. 21, 24 (2015) (observing that "[r]eported upper respiratory symptoms were . . . more frequent among households < 1 km (39%) compared with households > 2 km from gas wells").

30. The concept of externality has an uncertain and often unaddressed relationship to the concept of rights, including property rights. In welfare economics, anything could be an externality as long as it reduces the welfare of the party subject to the externality. Economics, from which the term externality is derived, takes as given the welfare function of individuals without judging as to what is included in the function. At the same time, implicit in most discussions of externalities is the idea that it is legitimate to weigh in social welfare the costs associated with the externality. If one steals cattle and then tries to graze them on a commons pasture being depleted by other people's cattle, one is subject to an externality from the other people's grazing practices, but it is arguable that that externality should not "count" in a social welfare calculus because the cattle were stolen. And from the perspective of how people and existing institutions on the ground actually react, it would seem plausible that there would be more resistance to institutional modifications to address externalities when there is no a question whether the parties bearing the externalities have legitimacy in complaining about them.

31. Hannah J. Wiseman, *Risk and Response in Fracturing Policy*, 84 U. COLO. L. REV. 729, 744 (2013).

32. Andrew J. Kondash et al., *The Intensification of the Water Footprint of Hydraulic Fracturing*, SCI. ADVANCES, Aug. 15, 2018, at 2. This increase in water use is due largely to operators drilling longer lateral wellbores to access more oil and gas; more fracking solution is needed for longer wells. Jean-Philippe Nicot et al., *Source and Fate of Hydraulic Fracturing Water in the Barnett Shale: A Historical Perspective*, 48 ENVTL. SCI. & TECH. 2464, 2466 (2014).

horizontally, and depending on the type of shale being developed, but it is somewhere between three to five million gallons of water, or more, per well.[33] Some fracking companies withdraw water from underground sources by drilling a well on the well site, purchasing water from a municipality or water district that pumps and distributes water from an underground source, or purchasing water from other well owners.[34] In other regions, fracking operators rely primarily on surface waters, and often water from small streams that can dry up quickly.[35]

When many operators frack wells in one region at the same time—and rely on the same water source—this can cause serious short-term depletions in supply.[36] This, in turn, can harm aquatic species or cause problematic short-term scarcity for other water users.[37] From a broader perspective, the use of water for fracking pales in comparison to industrial, agricultural, and municipal uses, but the short-term effects on quantity are substantial.[38] And in drought-prone regions, even relatively small users, including fracking companies, pose a longer-term concern.[39]

Water quality externalities overlap substantially with water quantity because one of the best ways to reduce freshwater use for fracking is to reuse or recycle water from another fracked well. Liquid oil and gas wastes pose one of the greatest challenges to operators because of their potential to pollute environmental resources—particularly water—and they are one of the limiting factors to production. Every well drilled into a shale formation generates some amount of salty brine, called "produced water," which comes up out of the well

33. Nicot et al., *supra* note 32.

34. *Id.* at 2468 (noting that much of the water for fracking in Fort Worth comes from the regional water district, although this district pumps water from surface reservoirs rather than underground sources, and that other municipalities also "provide water directly to operators").

35. Sally Entrekin et al., *Water Stress from High-Volume Hydraulic Fracturing Potentially Threatens Aquatic Biodiversity and Ecosystems in Arkansas, United States*, 52 ENVTL. SCI. & TECH. 2349, 2354 (2018) (noting that the majority of water withdrawals for fracking in Arkansas were from small streams); Nicot et al., *supra* note 32, at 2464.

36. *See, e.g.*, JAMES L. RICHENDERFER ET AL., WATER USE ASSOCIATED WITH NATURAL GAS SHALE DEVELOPMENT: AN ASSESSMENT OF ACTIVITIES MANAGED BY THE SUSQUEHANNA RIVER BASIN COMMISSION JULY 2008 THROUGH DECEMBER 2013, at 11 tbl.1 (2016), https://www.srbc.net/our-work/reports-library/technical-reports/299-natural-gas-water-use-susquehanna/docs/water-use-natural-gas-report.pdf (showing 346 water use permits for fracking issued in one Pennsylvania county in 2010); *cf.* Press Release, Susquehanna River Basin Commission, 64 Water Withdrawals for Natural Gas Drilling and Other Uses Suspended to Protect Streams (July 16, 2012) https://www.srbc.net/about/news/news-release.html?id=90 (noting that when streams drop below a minimum low flow level, as can occur when there are too many withdrawals for fracking, the SRBC requires withdrawals to temporarily cease).

37. *See* Entrekin et al., *supra* note 35, at 2350 (noting how fracking can cause water stress and defining water stress as "either the risk of water scarcity for people that is caused by increases in economic costs and competition among uses or as the extent and magnitude of altered natural streamflow that could result in loss of aquatic biodiversity and ecosystem function and services").

38. *See* Nicot et al., *supra* note 32, at 2464 (noting that although total fracturing "water use estimates represent a small fraction of water used in each state . . . the volumes may be significant locally, depending on competition with other sectors").

39. *Id.*

over its productive life.[40] This water is often saltier than seawater; if stored, transported, and disposed of improperly it can pollute drinking water, kill plants and animals, and cause other serious environmental problems.[41] Additional wastewater from fracked wells includes the fracking fluid itself, which flows out of the well after fracking ends and contains fracking chemicals.[42] Produced water and flowback both contain low levels of naturally occurring radioactive materials and other toxic constituents.[43] And both can be reused or recycled in other fracked wells—if other wells are under active development when the waste is generated—thus limiting the need to dispose of the wastes and providing a beneficial alternative to the use of freshwater for fracking.[44]

Reuse involves directly using the produced water and flowback to frack another well without first treating the water, whereas recycling involves fracking with treated wastewater from another well.[45] Despite their water quality and quantity benefits, recycling and reuse also have substantial externalities. They require holding large amounts of wastewater in large pits on site or in centralized holding ponds.[46] The water is then transported to a plant for treatment and sent to another well for fracking, or it is directly trucked or piped to other wells. Spills can occur during all of these transfer points. Indeed, some states, like Michigan, prohibit the use of pits for storing salty wastewater due to concerns about discharges,[47] and this largely prevents recycling and reuse. But other waste disposal options have substantial, and sometimes more harmful, externalities.[48]

Recycling and reuse are common in some regions, such as parts of Colorado and much of Pennsylvania, but they appear to have been a primary means of disposing of drilling and fracking liquid wastes only in Pennsylvania.[49] The predominant disposal option for produced water and flowback water is to

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40. The volume of produced water declines over time. *Id.* at 2468.

41. *See* T.L. Tasker et al., *Environmental and Human Health Impacts of Spreading Oil and Gas Wastewater on Roads*, 52 ENVTL. SCI. & TECH. 7081, 7089 (2018) (noting the potential for harm to aquatic life and human health).

42. *See* Andrea Vieth-Hillebrand et al., *Characterizing the Variability in Chemical Composition of Flowback Water—Results from Laboratory Studies*, 125 ENERGY PROCEDIA 136, 137 (2017).

43. Avner Vengosh et al., *The Geochemistry of Hydraulic Fracturing Fluids*, 17 PROCEDIA EARTH & PLANETARY SCI. 21, 23 (2017).

44. *See* Nicot et al., *supra* note 32, at 2464 (describing reuse from recycling).

45. *See id.* (differentiating and defining reuse from recycling).

46. *See* Michael Texter, Bureau of Waste Mgmt., Water Recycling/Oil and Gas Waste 9 (Jan. 15, 2015) (noting that wastewater to be reused is stored on or offsite).

47. *Hydraulic Fracturing in Michigan*, MICH. DEP'T OF ENV'T., GREAT LAKES, & ENERGY, https://www.michigan.gov/egle/0,9429,7-135-3311_4231-262172--,00.html (last visited Apr. 15, 2020) (noting that Michigan requires that produced water and flowback from fracked wells be contained in steel tanks rather than pits).

48. *See infra* notes 50–58 and accompanying text.

49. John A. Veil, Water Availability and Management in Shale Gas Operations (Sept. 26–29, 2010) http://www.gwpc.org/sites/default/files/event-sessions/12Veil_John.pdf ("In most shale gas plays, wastewater is disposed of through injection wells."). More injection wells are now being drilled in Pennsylvania. *See* U.S. ENVTL. PROT. AGENCY, REGION III, UNDERGROUND INJECTION CONTROL PERMIT NO. PAS2D701BALL AUTHORIZATION TO OPERATE CLASS II-D INJECTION WELL (2018) (approving a commercial brine disposal well, effective Mar. 7, 2018).

inject the water underground into an underground injection control (UIC) well.[50] UIC wells are most commonly drilled into depleted oil and gas formations, which have open pore space into which wastewater can flow, or into other porous underground formations.[51] These wells sometimes cause surface or groundwater contamination,[52] and in states like Arkansas, Ohio, Oklahoma, and Texas, they have triggered earthquakes.[53]

Other disposal outlets include discharging the water into surface water after treatment, and improper disposal can pollute the water and harm aquatic organisms. For produced water, but not flowback, some oil and gas operators also spread the water on the surface of land—either at the well site or elsewhere—or spray the water onto roads for dust or ice control.[54] In states with few UIC wells, operators also previously sent flowback and produced water to publicly-owned treatment works (POTWs) that accept a variety of liquid domestic and industrial wastes, such as sewage. These plants then treat the waste and discharge it into surface waters. After studies showed that oil and gas waste sent to POTWs was inadequately treated and polluted surface waters when discharged, the EPA banned this practice,[55] although the EPA is currently reconsidering the rule on remand from a court, and the compliance deadline has been extended.[56] Additional oil and gas wastewater disposal methods include evaporating the waste on site in pits and disposing of it at commercial oil and gas waste facilities.[57]

Beyond the wastewater disposal challenge, other substances at well sites have environmental externalities—and water quality impacts, in particular. Wastewater from drilling and fracking is typically stored in open pits on well

50. *See* Nicot et al., *supra* note 32, at 2469 (noting that most flowback from the Barnett Shale is disposed of in injection wells).

51. OHIO DEPT. OF NATURAL RESOURCES, UNDERGROUND INJECTION CONTROL (UIC) http://oilandgas.ohiodnr.gov/regulatory-sections/underground-injection-control (last updated Apr. 7, 2020) (noting that injection wells are drilled into depleted formations (those previously used to produce oil and gas) or brine-producing formations).

52. Jill E. Johnston et al., *Wastewater Disposal Wells, Fracking, and Environmental Injustice in Southern Texas*, 106 AM. J. PUB. HEALTH 550, 550 (2016).

53. *See, e.g.*, Cliff Frohlich et al., *The Dallas-Fort Worth Earthquake Sequence: October 2008 Through May 2009*, 101 BULL. SEISMOLOGICAL SOC'Y AMERICA 327 (2011); Cliff Frohlich, *Two-Year Survey Comparing Earthquake Activity and Injection-Well Locations in the Barnett Shale, Texas*, 109 PROC. NAT'L. ACAD. SCI. 13934 (2012); Katie M. Keranen et al., *Potentially Induced Earthquakes in Oklahoma, USA: Links Between Wastewater Injection and the 2011 M_w 5.7 Earthquake Sequence*, 41 GEOLOGY 699 (2013).

54. *See* Tasker et al., *supra* note 41, at 7082.

55. Effluent Limitations Guidelines and Standards for the Oil and Gas Extraction Point Source Category, 81 Fed. Reg. 41,845, 41,853 (June 28, 2016) (codified at 40 C.F.R. pt. 435 (2018)). *But see* Effluent Limitations Guidelines and Standards for the Oil and Gas Extraction Point Source Category—Implementation Date Extension, 81 Fed. Reg. 88,126, 88,126 (Dec. 7, 2016) (codified at 40 C.F.R. pt. 435 (2018)) (proposing to allow grandfathered sources to continue discharging to POTWs after the compliance date).

56. U.S. ENVTL. PROT. AGENCY, UNCONVENTIONAL OIL AND GAS EXTRACTION EFFLUENT GUIDELINES, https://www.epa.gov/eg/unconventional-oil-and-gas-extraction-effluent-guidelines#compliance (last updated July 5, 2019).

57. JOHN VEIL, U.S. PRODUCED WATER VOLUMES AND MANAGEMENT PRACTICES IN 2012, at 13 (2015).

sites, and these pits sometimes overflow and discharge wastes.[58] Chemicals used for fracking—some of which are toxic—are transported to well sites in trucks and then stored on site before they are used, and they can spill during transport, storage, or use.[59] Discharges of wastes and raw chemicals can pollute soil, surface water, and groundwater if they leak through permeable soil.[60] Often, plastic liners or even thicker impervious materials that operators place on well sites catch spills and prevent them from contaminating soil or water.[61] But not all well sites are lined in this manner. Many oil and gas operators rely on "secondary containment," such as dikes dug around pits to catch contamination from overflowing pits or other sources of spills. But secondary containment sometimes fails.[62] Surface discharges can also contaminate groundwater when they seep through soil.[63] And finally, underground, methane, fracking chemicals, oil, and other substances can seep out of wells into groundwater or into rock, and then through a natural conduit to groundwater, if wells are improperly cased (lined with steel pipes and cement) or if the casing fails.[64] Although much groundwater contamination is the result of the drilling process or faulty casing—not fracking directly—the *perception* of groundwater contamination from fracked wells is strong.[65]

58. *See, e.g.*, DEP'T OFFICE OF OIL & GAS MGMT, PA. DEP'T OF ENVTL. PROTECTION, COMPLIANCE REPORT 1829700 (Sept. 19, 2009) (noting that a Pennsylvania Department of Environmental Protection inspector received an operator report of a "pit leak in flowback impoundment. Operator observed dead vegetation in farm field below well site. Wastewater leaked out of pit, entered drainage channel & sediment trap which overflowed thru sediment fencing into field.").

59. *See, e.g.*, DEP'T OFFICE OF OIL & GAS MGMT, PA. DEP'T OF ENVTL. PROTECTION, COMPLIANCE REPORT 2172301 (June 5, 2013) (noting that while fracking chemicals were being blended onsite, 180 barrels spilled, two of which were discharged beyond containment areas on the site).

60. *See* Sherilyn A. Gross et al., *Analysis of BTEX Groundwater Concentrations from Surface Spills Associated with Hydraulic Fracturing Operations*, 63 J. AIR WASTE MGMT. ASS'N 424 (2013) (discussing the effects on groundwater); U.S. ENVTL. PROTECTION AGENCY, *supra* note 26, at 5–50.

61. Gina Banai, Oral Presentation at University of Pittsburgh School of Law Energy Law & Policy Institute (Aug. 2, 2013) (showing and describing a well site with a "floor").

62. *See, e.g.*, DEP'T OFFICE OF OIL & GAS MGMT, PA. DEP'T OF ENVTL. PROTECTION, COMPLIANCE REPORT 1957931 (Sept. 19, 2009) (noting a failure to properly store residual waste and concluding that the operator "needs to repair and maintain secondary containment").

63. U.S. ENVTL. PROTECTION AGENCY, *supra* note 26, at 5–50.

64. *See id.* at 6–70 (noting two cases of hydraulic fracturing contributing to groundwater contamination, as well as noting the range of casing failure rates estimated by studies of wells in the Pennsylvania's Marcellus Shale, with estimates ranging from three to ten percent of wells).

65. Anthony E. Ladd, *Stakeholder Perceptions of Socioenvironmental Impacts from Unconventional Natural Gas Development and Hydraulic Fracturing in the Haynesville Shale*, 28 J. RURAL SOC. SCI. 56, 74 (2013) (noting that "[c]oncerns over the potential for fracking to contaminate local groundwater sources or aquifers were . . . reported by almost two-thirds" of respondents to a survey); Jason L. Weigle, *Resilience, Community, and Perceptions of Marcellus Shale Development in the Pennsylvania Wilds: Reframing the Discussion*, 27 SOC. VIEWPOINTS 3, 9 (2011) (noting that among many concerns voiced, groundwater contamination was among the most common).

B. NEIGHBORHOOD QUALITY

The modern slick water method of fracking that has triggered a boom in domestic oil and gas development requires thousands of wells to be drilled and has thus impacted numerous individuals and the communities in which they live. And the growing literature addressing the risks of this practice suggests that risks fall largely at the local level, affecting broad aspects of the quality of life within communities.[66] Largely because fracked wells can and have been established near homes and schools, fracking thus imposes what we term a "neighborhood amenity" or "quality externality"—an externality particular to the residents who live, work, or send their children to school near wells. These externalities include concerns about the fumes from fracking, noise and traffic hazard from trucks going to and from the wells, groundwater contamination, and the perception that overall proximity to wells poses a health risk.[67] There is indeed research to support the view that residential proximity to fracking operations increases health risks.[68]

These perceived, diverse, proximity-based externalities comprise much of what we include under the label "neighborhood quality." But neighborhood quality also encompasses the distinct value or benefit of living in an aesthetically pleasing, quiet, (if you will) "picket fence" setting in which all or almost all uses are residential or otherwise "low impact."[69] This distinct value or benefit for property owners may account for a substantial increment of the market value of their properties.[70]

Neighborhood quality thus includes both the idea of a neighborhood free from what might be regarded as common law nuisances and hazards and a neighborhood that has a scale, density, and appearance that conforms to a traditionally powerful conception of what is a nice neighborhood in which to live. Neighborhood quality captures exactly what has been, as a historic matter,

66. *See* David B. Spence, *The Political Economy of Local Vetoes*, 93 TEX. L. REV. 351, 367–68 (2014) (describing the local impacts).

67. *See* Ladd, *supra* note 65, at 75 (noting that one third of residents interviewed expressed concerns about "noise, dust, lights, and odors"); Thurka Sangaramoorthy et al., *Place-based Perceptions of the Impacts of Fracking Along the Marcellus Shale*, 151 SOC. SCI. & MED. 27, 33 (2016) ("[R]esidents expressed concern about environmental changes brought about by fracking operations such as increased traffic, land erosion and mudslides, wastewater, chemical runoff, and changes in air and water quality.").

68. *See* Janet Currie et al., *Hydraulic Fracturing and Infant Health: New Evidence from Pennsylvania*, 3 SCI. ADVANCES, Dec. 13, 2017, at 1 (showing lower birth weights of infants of mothers who live close to fracked well sites); Marsha Haley et al., *Adequacy of Current State Setbacks for Directional High-Volume Hydraulic Fracturing in the Marcellus, Barnett, and Niobrara Shale Plays*, 124 ENVTL. HEALTH PERSP. 1323, 1330 (2016) ("Based on historical evacuations and thermal modeling, people within [state-regulated] setback distances are potentially vulnerable to thermal injury during a well blowout. According to air measurements and vapor dispersion modeling, the same populations are susceptible to benzene and hydrogen sulfide exposure above health-based risk levels.").

69. The Supreme Court emphasized that preserving this type of setting is a value encompassed within the health, safety, and welfare of a community in *Village of Euclid v. Ambler Realty Co.*, 272 U.S. 365, 395 (1926).

70. *See generally* LEE ANNE FENNELL, THE UNBOUNDED HOME: PROPERTY VALUES BEYOND PROPERTY LINES (2009) (describing the importance of neighborhood aesthetic and the disputes that arise over associated preferences).

a centerpiece of American zoning, dating back to the famous *Euclid* case in which the Supreme Court validated the right—in a sense the property right—of residential property owners to maintain physical distance between themselves and not only potentially loud and dangerous industrial uses but also uses that are inconsistent with the airiness and pleasantness of a low-density residential neighborhood.[71] As Lee Fennell suggests, the idea that residents maintain a kind of property right to neighborhood quality—and hence that the externalities that threaten neighborhood quality "count" in social, political, and legal discourse—is entrenched in our land use regime.[72]

There is clearly some overlap between the water supply externality and water quality externality and what we call the neighborhood quality externality. But the neighborhood externality, in addition to encompassing costs unconnected to water quantity or quality, has a different scale from the other two externalities. Water supply and quality concerns can implicate geographic areas beyond a discrete neighborhood or single locality and may (and perhaps usually will) be based not simply on a single or cluster of fracking wells but rather on the cumulative effects of a large number of wells spread out over many miles. The difference in scale of the water supply and water quality externality as compared to the neighborhood quality externality means that different actors, different institutions, and a different number of actors and institutions may be involved. Most obviously, local governments would seem to be a more natural focal point for governance regarding the neighborhood externality than the water supply and quality externalities.

The following Part explores these three types of often-overlapping externalities through case studies in three states, analyzing the extent to which the Demsetz thesis, as modified by subsequent legal scholarship, explains responses to growing externalities.

II. A QUALITATIVE EMPIRICAL TEST OF DEMSETZ

Fracking—an industrial activity that has expanded rapidly, and in diverse areas—offers a prime test of the extent to which growing externalities generate Demsetzian responses. As we explored in the introduction, Demsetz theorized that increasing resource competition and associated externalities of resource use would make the costs of establishing and enforcing more clearly defined property rights in that resource worthwhile. The theory, as refined by subsequent legal, political, sociological, and economic research, is also consistent with the rise of innovative governance institutions and softer mechanisms for mediating the use of a commons, such as monitoring and community-industry agreements.

71. *See Village of Euclid*, 272 U.S. at 375, 388, 391.

72. *See* Fennell, *supra* note 15, at 16, 16 n.6 ("A family may privately own a house and the lot it sits on, but that family also holds interests in common with other households with respect to the neighborhood's ambience and the community's amenities . . . . [Z]oning grants even those who live in ordinary neighborhoods a form of collective property rights." (footnote omitted)).

For the externalities of the fracking boom fleshed out in Part I, here we analyze state and community responses in Pennsylvania, Colorado, and Texas. We select these states because they have experienced some of the most substantial fracking activity, and they also provide diverse backdrops for testing the Demsetz theory, including different geographies and climates, environmental resources, historic resource production, law, culture, and politics. And, due to the location of shales beneath these states, the types of communities in which fracking occurs vary substantially.

In Pennsylvania, a state that vacillates between Republican and Democratic tendencies,[73] fracking has tended to occur in relatively rural communities dominated by industries such as agriculture.[74] Although fossil fuel development was common relatively early in the state's history, with coal mining and other extractive industries leaving a relatively heavy environmental footprint, the state had not experienced recent widespread natural gas development until the fracking boom hit.[75] The state also has a very different legal regime from the perspective of water resources as compared to relatively arid Texas and Colorado. Pennsylvania follows English "riparian" water law, in which users must ensure that their water use does not negatively impinge on other users' rights,[76] whereas Texas and Colorado are prior appropriation "first in time" states, as we discuss in this Part.[77] Further, part of Pennsylvania had relatively active regional governance institutions for water governance in place prior to the fracking boom.[78]

Colorado is similar to Pennsylvania in that it has a history of resource extraction, but fracking has expanded development in parts of the state that had not recently experienced as much activity. Despite some similarities to Pennsylvania, it offers a helpful contrast with Pennsylvania's characteristics in terms of its climate, geography, and location of fracking. Although fracking is also common in some relatively rural areas in Colorado, its direct externalities, such as air pollution, have also directly impacted the Denver metroplex.[79] And Colorado is a "purple" state from a political perspective, hosting strongly

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73. *See* Daniel Bush, *"Are We a Red State or a Blue State?" Life in a Pennsylvania Swing County 100 Days into Trump's Presidency*, PBS (Apr. 29, 2017, 11:36 AM), https://www.pbs.org/newshour/politics/red-state-blue-state-life-pennsylvania-swing-county-100-days-trumps-presidency.

74. *See, e.g.*, Yelena Ogneva-Himmelberger & Liyao Huang, *Spatial Distribution of Unconventional Gas Wells and Human Populations in the Marcellus Shale in the United States: Vulnerability Analysis*, 60 APPLIED GEOGRAPHY 165, 171 (2015) (showing that many wells were fracked in poor, rural areas).

75. Robinson Tp. v. Commonwealth of Pa. (*Robinson II*), 83 A.3d 901, 976 (Pa. 2013) ("Pennsylvania has a notable history of what appears retrospectively to have been a shortsighted exploitation of its bounteous environment.").

76. *See infra* note 178 and accompanying text.

77. *See infra* notes 211–217 and accompanying text.

78. *See infra* notes 179–185 and accompanying text.

79. *See* Dale Wells, Air Pollution Control, Colo. Dep't of Pub. Health & Env't, Condensate Tank Emissions 2 (unpublished paper), https://www3.epa.gov/ttnchie1/conference/ei20/session6/dwells.pdf (noting that oil and gas development was a leading cause of air pollution in the Denver region).

divergent political views in part due to the influx of people from relatively liberal states, such as California.[80]

Our final case study, Texas, tests the Demsetz thesis in another relatively arid state in which the oil and gas industry has long dominated and has been welcomed by many communities. The fracking boom in parts of Texas has been predominantly urban—with much of the development of the Barnett Shale, a natural gas-containing rock formation centered beneath the Fort Worth area[81]—and predominantly rural in others. Unlike in Pennsylvania and Colorado, the Republican Party clearly reigns within Texas;[82] the continued growth of urban areas in the state has threatened this dominance but has not made substantial inroads.

The sections that follow explore the three major externality groups that we have identified for fracking—the neighborhood amenity, water quantity, and water quality externalities—within these three case study states.

A. Neighborhood Quality

The effects of fracking at the local level are particularly pronounced, and the boom in activity as workers and equipment pour into towns might be expected to generate a classic Demsetzian response. Thousands of trucks travel to and from each fracked well site,[83] generating noise, dust, air pollution, traffic congestion, and road damage. Generators, rig engines, and other equipment running on site are noisy and emit air pollution, and lights shine around the clock unless regulated.[84] These and other community externalities are substantial in each of the states that we studied, but responses also varied substantially and did not consistently hew to a Demsetzian framework.

1. *Pennsylvania*

Before fracking became a reality in Pennsylvania, the state had a long history with other extractive industries, both conventional oil drilling and (famously) coal mining.[85] Prior to the advent of fracking, localities' rights to protect neighborhood quality were embodied in the Pennsylvania Municipalities Planning Code, which empowers localities to, among other things, zone for

80. Sam Brasch, *Purple State Blues*, COLO. PUB. RADIO (Oct. 11, 2018), http://www.cpr.org/news/purplish/purple-state-blues (noting a political scientist's view that Colorado remains a purple state despite recent Democratic presidential candidate victories there).

81. *See City of Fort Worth Gas Well Status February 2018*, *supra* note 21.

82. *See* Ben Philpott, *Why Is Texas So Red, and How Did It Get That Way?*, HOUS. PUB. MEDIA (Oct. 31, 2016, 6:30 AM), https://www.houstonpublicmedia.org/articles/news/politics/2016/10/31/174443/why-is-texas-so-red-and-how-did-it-get-that-way/.

83. *See* CESAR QUIROGA ET AL., TEX. A&M TRANSP. INST., TRAFFIC LOADS FOR DEVELOPING AND OPERATING INDIVIDUAL WELLS 6 tbl.2 (2016), https://static.tti.tamu.edu/tti.tamu.edu/documents/409186/IR-16-03.pdf (showing 5513 trucks required to frack and refrack an average well in the Barnett Shale region and 16,160 trucks needed for this same purpose in the more rural Eagle Ford Shale region).

84. *See, e.g.*, Sci. Advisory Bd., *supra* note 23, at 11 (providing a resident's statement explaining that "the noise and generated dust . . . was impossible to keep from his windows").

85. *See supra* note 75 and accompanying text.

permissible land uses.[86] By and large, the Pennsylvania courts had held that localities are able to zone where conventional oil and gas drilling or mining occurs within a locality.[87]

But the question remained whether the same interpretation would apply to fracked oil and gas wells, as this activity boomed in the Marcellus Shale and became a reality or potential reality for many localities. In 1996, a pre-fracking amendment to the Pennsylvania Oil and Gas Act prohibited localities from imposing on oil and gas operations "conditions, requirements or limitations on the same features of oil and gas well operations regulated by" that Act.[88] In terms of the neighborhood quality externality from fracking, the 1996 amendment left several questions open. These included whether the location of a fracked well was a "feature" of oil and gas operations or not, and whether setback requirements that require minimum distances between wells and residences, other structures, or water resources were an impermissible regulation of a feature of drilling.

As Demsetz's theory would predict, the rise of fracking and perceived neighborhood quality externalities has forced a greater specification of the relative rights of fracking operators to frack where they choose and neighborhoods to zone in such a way as to protect neighborhood quality. The specification, however, has not been linear.

In 2009, the Pennsylvania Supreme Court read the 1996 amendment to only preempt local regulation of oil and gas operations to the extent such regulations addressed matters *other than* the location of drilling; localities could impose location restrictions to address local interests that the zoning power is designed to serve and that are distinct from state-wide economic and general public health considerations.[89] The court explained that, while the State had an interest in uniformity, there was a distinct local interest protected by zoning that uniform state regulation could not adequately address—zoning controls that address overall "community development objectives."[90]

In 2012, the Pennsylvania legislature, in an explicit attempt to make Pennsylvania as friendly as possible to fracking, enacted a statute that expressly precluded all local zoning that would affect oil and gas operations, including partial or full exclusions of operations from a locality and any setback requirements exceeding those required by the state.[91] The statute went so far as

86. 1968 Pa. Laws 170.

87. *See, e.g.*, Nalbone v. Borough of Youngsville, 522 A.2d 1173, 1176 (Pa. Commw. Ct. 1987) (allowing zoning for oil and gas development).

88. 58 PA. CONS. STAT. § 601.602 (1996).

89. Huntley & Huntley v. Council of Oakmont, 964 A.2d 855, 866 (Pa. 2009) (allowing an "overall restriction on oil and gas wells" in a residential district); *see also* Range Res. Appalachia v. Salem Twp., 964 A.2d 869 (Pa. 2009).

90. *Huntley*, 964 A.2d at 865. The court's opinions, however, emphasized that local regulation of oil and gas siting could not exceed that generally encompassed within the zoning power. *Id.* at 860.

91. 58 PA. CONS. STAT. §§ 2301–3504 (2020).

to require that local governments allow oil and gas development in every zoning district within the locality—even residential districts.[92]

In 2013, however, the Pennsylvania Supreme Court struck down the provisions related to local zoning and certain other portions of the 2012 Act, relying upon the 1971 Environmental Rights Amendment (ERA) of the state constitution.[93] That Amendment, to which Pennsylvania Courts had previously given little effect,[94] provides that "[t]he people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment."[95] And the ERA includes an affirmative mandate: as trustee of the State's natural resources, "the Commonwealth shall conserve and maintain them for the benefit of all the people*.*"[96]

The Pennsylvania Supreme Court interpreted the ERA as a response to a history of environmental degradation in Pennsylvania, including degradation from coal mining.[97] In striking down a provision of the 2012 law that would prohibit any local zoning restrictions regarding fracking operations, the court explained that the resulting environmental degradation would be inconsistent with the entrustment of natural resources in the Commonwealth for the benefit of all people, including future generations.[98]

After the *Robinson II* decision in 2013 and a *Robinson III* opinion in 2016 that reinforced and extended the court's previous holdings,[99] it is clear that in Pennsylvania a locality may partially or wholly exclude fracking operations as long as it does so in a way that is rationally related to permissible goals of zoning—notably, maintaining the aesthetic character of a locality and preservation of local environmental resources.[100] It is also clear that local setback provisions, as long as they are rationally related to permissible zoning objectives, are lawful.[101]

However, the *Robinson* decisions do not unambiguously address all the concerns that might be housed under the term neighborhood quality externality. First, the decisions do not purport to overturn prior case law affirming that the state may require uniformity in the regulation of actual oil and gas operations, including such things as casing requirements and natural gas transport and waste disposal requirements.[102] At the same time, the decisions emphasize that the flaw

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92. 58 PA. CONS. STAT. § 3304 (2020).

93. Robinson II, 83 A.3d 901, 901 (Pa. 2013).

94. *See generally* John C. Dernbach, *Taking the Pennsylvania Constitution Seriously When It Protects the Environment*: *Part II—Environmental Rights and Public Trust*, 104 DICK. L. REV. 97 (1999) (exploring previous applications of the Environmental Rights Amendment).

95. PA. CONST. art. I, § 27.

96. *Id.*

97. *Robinson II*, 83 A.3d at 944.

98. *Id.* at 979–80.

99. Robinson Twp. v. Commonwealth of Pa. (*Robinson III*), 147 A.3d 536 (Pa. 2016).

100. *Id.* at 566.

101. *Id.*

102. *See* 25 PA. CODE § 95.10 (2020) (requiring treatment of wastewater prior to sending it to a wastewater treatment plant); 25 PA. CODE § 78.83 (establishing casing requirements).

of the 2012 statute (in part) was that it deprived localities of a right to take action to address "a distinctive local environmental issue of importance to the residents of the municipality,"[103] and the ERA upon which the court relied references the people's right to air and pure water. There is thus ambiguity in the decisions as to what—beyond location restrictions and setback mandates—localities may be permitted to require from fracking operators.

Second, the *Robinson* decisions affirm the rights of localities but not of specific neighbors vis-a-vis fracking operations: neighbors concerned about fracking coming to their area can only do something about it if they command the attention and support of the local politicians making local zoning law. And in fact, much of the post-*Robinson* litigation seems to involve residents who are aggrieved that their locality is not doing enough to restrict fracking near them.[104] For discrete groups of residents, it is possible that the perceived neighborhood quality externality from new fracking wells would be large but the locality nonetheless would do nothing because the perceived benefits of the fracking for the locality as a whole outweigh the costs to the aggrieved residents, or because industry money and power have distorted local politics.[105]

With these caveats, it is reasonable to conclude that the Pennsylvania story today tracks Demsetz's theory. With new technology, a resource once thought to have little economic value—Marcellus Shale natural gas—becomes the target of intense economic activity. This intensification of resource use generated or threatened to generate neighborhood quality externalities, and political and then legal conflict ensued. The exact property rights of the resource users (fracking companies) were specified, over several years of contestation, to include rights to operate free of essentially all local regulation as to the process of drilling but subject to local area location and setback restrictions. These kinds of restrictions, in the aggregate, have the potential to reduce the overall neighborhood quality externalities of fracking by forcing fracking operators to internalize the costs of not operating at all in localities where neighbors see such operations as a large threat and, in other localities, by limiting the density of wells and the range of allowable site selection choices.[106]

103. *Robinson III*, 147 A.3d at 561.

104. *See, e.g.*, Frederick v. Allegheny Twp. Zoning Hearing Bd., 196 A.3d 677 (Pa. Commw. Ct. 2018) (challenging a local ordinance that allowed oil and gas development in all districts within the municipality); Gorsline v. Bd. of Supervisors of Fairfield Twp., 186 A.3d 375 (Pa. 2018) (challenging a local government's grant of a conditional use permit for a well).

105. JEFFREY M. BERRY ET AL., RAPPAPORT CTR., POWER AND INTEREST GROUPS IN CITY POLITICS (2006), https://www.hks.harvard.edu/sites/default/files/centers/rappaport/files/berry_interest_groups.pdf (exploring the extent to which capture arises at the local level); Richard G. Newell & Daniel Raimi, *Shale Public Finance: Local Government Revenues and Costs Associated with Oil and Gas Development* 67 (Natl. Bureau of Econ., Working Paper No. 21542, 2015), https://www.nber.org/papers/w21542.pdf (describing local officials in certain Pennsylvania townships who cited "net positive financial impact" from fracking).

106. *See, e.g.*, 1968 Pa. Laws 247, ch. 6, art. VI, § 603 (listing oil and gas wells as a conditional use within all zoning districts).

2. *Colorado*

The neighborhood quality externality has been the subject of intense contestation in Colorado, and for good reasons. The heart of oil and gas fracking in Colorado is the Front Range, the home of heavily-populated Boulder County and fast-growing Weld County. Weld County alone already has more than 23,000 active wells.[107] As the *New York Times* reported, "[d]rilling applications in the state have risen 70 percent in . . . [one] year, while the area north of Denver is expected to double in population by 2050."[108] Thus, the collision of drilling with suburban and urban living is at least as marked in Colorado as it is in Texas or Pennsylvania.

At the same time, the cultural, political, and economic realities of Colorado foster polarization over fracking. Like Pennsylvania and unlike Texas, Colorado is not usually described as an oil and gas-industry-dominated state, but it is a state where extractive industries have a long history and have usually been encouraged by state and local government.[109] At the same time, Colorado has very strong environmentalist forces at the state (and not just local) level that are generally hostile to fossil fuel extraction and sensitive to risks of environmental harm.[110] For these reasons, a wider range of possible outcomes regarding the legal treatment of fracking at the state level is conceivable in Colorado, ranging from relatively modest regulation to very strict regulation bordering on a partial ban.

We see this possible range in outcomes in the back-and-forth over fracking in Colorado politics in recent years. First there was a movement to place on the ballot a strongly anti-fracking referendum in 2014.[111] That was followed by a gubernatorial task force charged with a near-impossible mission: to find a peaceful compromise among industry, local government, and environmentalist forces.[112] Peace has not prevailed, and there has been continued contestation over the legal status of fracking at the state level. Anti-fracking forces were able

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107. Troy E. Swain, *Weld County Oil & Gas Update* (2018), https://www.weldgov.com/UserFiles/Servers/Server_6/File/Departments/Planning%20&%20Zoning/Oil%20and%20Gas/Updates/Oil%20%20Gas%20Update%20APR%202018.pdf.

108. Turkewitz, *supra* note 23.

109. *See* Swain, *supra* note 107 (advertising and championing the fact that Weld County hosts 90% of Colorado's oil development); Cary Weiner, *Oil and Gas Development in Colorado*, COLO. STATE UNIV. EXTENSION (2014), https://mountainscholar.org/bitstream/handle/10217/185140/AEXT_106392014.pdf?sequence=1&isAllowed=y (noting initial exploration wells as early as 1881 and a substantial increase in drilling activity in the 1990s); *see also* Charles Davis, *The Politics of "Fracking": Regulating Natural Gas Drilling Practices in Colorado and Texas*, 29 REV. POL'Y RES. 177, 185 (2012) ("Colorado has historically been a probusiness state in terms of facilitating industry access to the development of natural resources, including natural gas.").

110. *Id.* at 186 (noting the "size and importance of the environmental policy constituency in Colorado").

111. Maeve Reston, *Deal Will Keep Fracking Battle Off Colorado Ballot*, L.A. TIMES (Aug. 4, 2014, 10:52 PM), https://www.latimes.com/nation/politics/politicsnow/la-pn-colorado-deal-fracking-ballot-20140804-story.html.

112. OFFICE OF THE GOVERNOR, STATE OF COLO., EXEC. ORDER NO. B 2014 005 (2014), https://firebasestorage.googleapis.com/v0/b/torid-heat-3070.appspot.com/o/Programs%2FOGTF%2FEOCreatingOGTaskForce.pdf?alt=media&token=752981f0-ae9c-45bf-8ad1-2cd5063ad530.

to place on the 2018 ballot a referendum that would have mandated a 2500 foot minimum setback for wells throughout the state.[113] The referendum did not pass but garnered forty-three percent of the vote, despite a massive opposition campaign by the oil and gas industry.[114] Most recently, the election of a new governor sparked a state-level effort to enhance environmental and community-based productions relating to oil and gas development. The sweeping Senate Bill 181, enacted by the state legislature and signed by the governor in 2019, requires the state oil and gas agency to promulgate stricter controls of air emissions from oil and gas exploration and production, promulgate a variety of other environmental rules, such as rules to ensure well integrity, and write rules that would require companies to consider alternative locations for oil and gas activities proposed near populated areas.[115] Additionally, the bill gives clear and relatively extensive powers to local governments to regulate oil and gas development, including, among others, the location and siting of wells and other facilities, requirements for financial securities and insurance, and "[a]ll other nuisance-type effects of oil and gas development."[116] The bill also gives local governments general planning powers for "orderly use of land and protection of the environment" and allows them to inspect facilities, impose fines, and levy permitting fees.[117]

Past political uncertainty at the state level—particularly as to the range of legally permissible local regulation of fracking—has produced in Colorado one type of Demsetzian outcome that we do not see in Texas or Pennsylvania to any substantial extent. This outcome consists of contractual, purportedly enforceable agreements between localities and fracking operators that set forth the relative rights of the locality and the fracking operators and that, in some respects, go beyond state regulatory requirements.[118]

Prior to the fracking boom, Colorado law was ambiguous as to the rights of localities to adopt regulation affecting oil and gas drilling. On the one hand, Colorado has long had an agency devoted to oil and gas regulation—the Colorado Oil and Gas Conservation Commission (COGCC)—and, even before the fracking boom, the state had fairly comprehensive regulations governing drilling, production, and waste disposal.[119] By 2008, the State had adopted a set of fracking-specific regulations, which have been modified and expanded

113. John Aguilar, *Prop 112 Fails as Voters Say No to Larger Setbacks for Oil and Gas*, DENVER POST (Nov. 6, 2018, 7:13 PM), https://www.denverpost.com/2018/11/06/colorado-proposition-112-results/.

114. *Id.*

115. S. 19-181, Reg. Sess., at §§ 3, 12 (Colo. 2019) (adding 25-7-109 to the Colorado Revised Statutes, and amending 34-6-106, respectively).

116. *Id.* at § 4 (adding 29-20-104 to the Colorado Revised Statutes).

117. *Id.*

118. *See infra* notes 135–143 and accompanying text.

119. *See* COLO. CODE REGS. § 404-1:100 (proposed 2008) (showing 173 pages of rules and substantial changes in 2008, including some changes specific to fracking).

substantially since then.[120] Thus, as early as 2008—and until legislative clarification emerged in 2019—there was a basis for the argument that the state had occupied the field of fracking regulation and/or that stricter local regulation and local bans would present an operational conflict with state regulation and thus be preempted on that basis.

On the one hand, Colorado is a strong "home rule" state: the state constitution confers on home rule localities a right to legislate on matters of local concern even in the face of a conflicting state statute.[121] There is pre-fracking boom precedent in Colorado that suggests a reasonably high hurdle for energy producers who seek to invalidate local zoning regulation on the basis of operational conflict preemption. In *Board of County Commissioners of La Plata County v. Bowen/Edwards Assocs.*, the Colorado Supreme Court held that Colorado's Oil and Gas Conservation Act does not wholly preempt a county "from exercising its land-use authority over any and all aspects of oil and gas development and operations within the county."[122] In *Voss v. Lundvall Bros*, the Colorado Supreme Court affirmed the invalidation of a total ban on drilling enacted by a home rule municipality, but at the same time acknowledged that home rule city land use regulations on oil and gas development that could be harmonized with state law should stand.[123]

As Demsetz's theory would suggest, the explosion in drilling in Colorado created pressure for a greater specification of property rights and in particular a specification of the limits, if any, that could be imposed on fracking operations in the interest of tempering neighborhood quality externalities. With respect to setbacks, the nexus of activity was the COGCC, which in 2013 adopted one of the strictest state minimum setback regulations in the United States.[124] State permitting regulations also were reformed to, at least in theory, mandate more local input and more consideration of environmental factors.[125]

As in Texas, it was a local *ban* on fracking and another local long-term moratorium that spawned major litigation to further clarify rights in the context

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120. *See, e.g.*, COLO. CODE REGS. §§ 404-1:337, 906 (2013) (showing final spill reporting rules adopted in 2013); COLO. CODE REGS. §§ 305A, 604.c.(4), 302.c. (2016) (showing rules regulating wells in urban areas); COLO. CODE REG. § 609 (2012) (showing a rule requiring testing of groundwater prior to drilling).

121. COLO. CONST. art. XX, § 6.

122. 830 P.2d 1045, 1048 (Colo. 1992).

123. 830 P.2d 1061, 1069 (Colo. 1992). The key ambiguity that the Colorado Court did not resolve is the meaning of "can be harmonized with the development and production of oil and gas in a manner consistent with the stated goals of the Oil and Gas Conservation Act." *Id.*

124. COLO. CODE REGS. § 604 (2013) (showing, effective 2013, a requirement that wells and production facilities to be 500 feet from building units); Hannah J. Wiseman & Francis Gradijan, Regulation of Shale Gas Development, Including Hydraulic Fracturing 45 (June 15, 2012) (unpublished manuscript) (showing other state setback requirements for oil and gas wells from buildings ranging from 150 feet to 1000 feet, with only Maryland and West Virginia exceeding the 500-foot requirements). In 2018 the COGCC also adopted a setback rule requiring a 1,000-foot setback from building units and high occupancy units such as schools and nursing facilities. COLO. CODE REGS. § 604 (2018).

125. COLO. CODE REGS. § 404-1:216 (2008) (providing, in a 2008 rule revision, incentives for operators that chose to enter into comprehensive drilling plans, which included provisions to protect "public health, safety, welfare, and the environment" and involved numerous parties in drafting the plans).

of neighborhood quality. At the local level, by 2014, there were a number of major Colorado localities that had adopted bans or five-year moratoria on fracking or were poised to do so.[126] The oil and gas industry petitioned the Colorado Supreme Court to resolve the question of where local authority ended with respect to fracking, but, unlike in Pennsylvania, the Colorado Supreme Court offered a specification of rights that favored the oil and gas industry. That specification, however, did not resolve all the ambiguity.

In *City of Longmont v. Colo. Oil & Gas Ass'n*,[127] the Colorado Supreme Court affirmed a trial court decision invalidating a Longmont ordinance that prohibited hydraulic fracturing and the storage of associated wastes in Longmont.[128] As had the trial court, the Colorado Supreme Court held that the ordinance was not expressly or impliedly preempted by the Colorado legislature but rather was preempted on the basis of an "operational conflict."[129] The court found that a total ban would frustrate the state statutory goals of promoting efficient, non-wasteful development of oil and gas resources, consistent with the protection of public health and welfare and the environment.[130] The court rejected the more extreme argument put forth by industry that "the [State] Commission has the exclusive authority to regulate the technical aspects of oil and gas operations and that such technical" regulation by a locality "constitutes a de facto operational conflict."[131] At the same time, the court held that the State interest in uniformity in fracking regulations would be undermined by a local ban.[132]

The court followed similar reasoning in another case decided the same day, holding in *City of Fort Collins v. Colorado Oil & Gas Ass'n* that a long-term five-year moratorium on fracking was also operationally preempted.[133] The *Longmont* and *Fort Collins* decisions could be read to preempt only local bans and moratoria, or more broadly to preempt local regulation of fracking that is stricter than state requirements.[134] The 2019 legislation granting local governments relatively broad regulatory powers largely quashed this latter interpretation, but the issue remained unsettled until then.

126. Joel Minor, *Local Government Fracking Regulations: A Colorado Case Study*, 33 STAN. ENVTL. L.J. 59, 110–11 (2013).

127. 369 P.3d 573 (Colo. 2016).

128. *Id.* at 577.

129. *Id.* at 584.

130. *Id.* at 584–85.

131. *Id.* at 585.

132. *Id.* ("The Oil and Gas Conservation Act and the Commission's pervasive rules and regulations . . . convince us that the state's interest in the efficient and responsible development of oil and gas resources includes a strong interest in the uniform regulation of fracking.").

133. *Id.* at 586.

134. The one of the few (if only) post-*Longmont* and *Fort Collins* cases to date, an ordinance from the locality of Thornton adopting a mandatory setback that exceeds the state standard by 250 feet, was recently struck down by a trial court, which agreed with the industry's expansive reading of the *Longmont* and *Fort Collins* decisions. Cathy Proctor, *Judge Rules Part of Thornton's Oil and Gas Regs Violates State, Federal Law*, DENVER POST (Apr. 25, 2018, 10:50 AM) https://www.bizjournals.com/denver/news/2018/04/25/judge-rules-part-of-thornton-s-oil-and-gas-regs.html.

Both before and after a win in the Colorado Supreme Court in 2016, fracking permit applicants have been willing to strike compromise deals with localities in the form of memoranda of understanding (MOUs) that, on their face, impose contractually binding obligations beyond those imposed by state law.[135] As already suggested, one motivation for industry's embrace of MOUs might be the polarization in the Colorado politics of fracking; given the realistic possibility of strict state regulation in the future or express state authorization of local bans, it may be reasonable for industry both to try to temper anger and resentment at the local level—which, of course, can fuel state-level anti-fracking efforts—and to secure the necessary local approvals as fast as possible. Localities have explicitly offered streamlined, expedited local permitting in return for an applicant's willingness to negotiate a MOU.[136] Good will in the community—a social license to operate, so to speak—might also be a motivation for the industry's substantial embrace of MOUs: whatever the formal state and local law, it is easier for operators to do business if they have at least some local goodwill.[137]

The MOUs vary from locality to locality but often address common subjects, including setbacks (especially wellhead setbacks from residential and other high-occupancy buildings and waste pit setbacks from residences and wellheads); roads (especially ways to minimize dust and congestion on roads); air quality (ranging from dust control to vapor capture and limits on flaring; noise prevention and mitigation); disclosure of chemicals added to water as part of fracking; required procedures for chemical and waste storage, emergency planning, and spill response; and wildlife habitat protection.[138] Typically, the

135. *See* Austin Shaffer et al., *Memoranda of Understanding and the Social Licence to Operate in Colorado's Unconventional Energy Industry: A Study of Citizen Complaints*, 35 J. ENERGY & NAT. RESOURCES L. 69, 71 (2017) (noting the increasingly common use of MOUs in Colorado). There are many types of "supraregulatory" agreements that communities can enter into, but MOUs appear to have been the most common form in Colorado. Other agreements include, inter alia, impact and benefit agreements, in which communities receive money or in-kind donations from industry in exchange for cooperating with development; environmental agreements, in which industry commits to mitigation of certain impacts; and socioeconomic agreements, which address "broader" economic considerations and can involve industry commitments to benefit the locality or region by, for example, hiring local employees. Lindsay Galbraith et al., *Towards a New Supraregulatory Approach to Environmental Assessment in Northern Canada*, 25 IMPACT ASSESSMENT & PROJECT APPRAISAL 27, 28 (2007). Good neighbor agreements, in turn, give communities information about extraction operations, voice concerns about impacts, and address those concerns. Sarah M. Zuzulock & James R. Kuipers, *The Good Neighbour Agreement: A Proactive Approach to Water Management Through Community Enforcement of Site-Specific Standards*, 53 GREENER MGMT. INT'L 73, 73 (2006); *see also* Tara Righetti, *Contracting for Sustainable Surface Management*, 71 ARK. L. REV. 367, 385 (2018) (describing these and other types of agreements and providing sources).

136. *See, e.g.*, Kristen van de Biezenbos, *Contracted Fracking*, 92 TUL. L. REV. 587, 634–35 (2018) (discussing streamlining or expediting of permits as an incentive for industry to enter contracts with localities); *see also* RockPick, *Arapahoe County OKs Agreement to Expedite Fracking Applications*, NIOBRARA NEWS (Apr. 3, 2013), https://www.niobraranews.net/hydrofracking/arapahoe-county-oks-agreement-expedite-fracking-applications.

137. Shaffer et al., *supra* note 135, at 70.

138. *See, e.g.*, Memorandum of Understanding from City of Brighton 3, 11, 12 (May 11, 2015), http://www.oilandgasbmps.org/docs/CO166_Brighton_Model_MOU.PDF (requiring "noise mitigation

operator agrees to include the MOU as an attachment to its permit from the state agency. Some of these requirements may go to matters not covered by state regulation, but some clearly do. For example, the City of Brighton MOU requires operators to use "best efforts to locate the wellhead or Production Facility outside of the buffer zone—at least 1,500' from any High Occupancy Building Unit,"[139] but the state rule enhancing setbacks in 2018 has as the maximum required setback only 1000 feet.[140]

The MOUs, to be sure, are not without their critics. While the agreements purport to be enforceable on their face and typically are incorporated by reference into COGCC permits, it is unclear whether the COGCC would seek to enforce their terms in the event MOU non-compliance came to light.[141] A locality presumably could go to court for enforcement, and some agreements specifically recite the right of the parties to the MOU to obtain injunctive relief in court,[142] but a court might question whether there is adequate, lawful consideration for the MOU as a contract. Even if MOUs are subject to state agency or court-ordered enforcement, many of the MOUs lack specific monitoring and reporting requirements, so violations might go unnoticed. MOUs, too, sometimes alienate activists within the community and, as compromise measures, may engender lukewarm enthusiasm at best.[143]

Whatever their arguable limits, MOUs do help specify rights to a greater degree than the background Colorado law. As genuine compromise measures, they encourage greater internalization of neighborhood externality costs than otherwise would occur. In this sense, they fully track Demsetz's theory. Moreover, by creating a framework for ongoing, joint governance on the part of industry and the locality, MOUs would seem to represent what Smith calls a

measures," "air quality mitigations," "Fugitive Dust suppression," and other measures). The Intermountain Oil and Gas BMP Project maintains a database of MOUs, identifying the different features of the MOUs. *Database of MOU BMPs*, INTERMOUNTAIN OIL AND GAS BMPS, http://www.oilandgasbmps.org/resources/MOU-database-BMPS.php.

139. Memorandum of Understanding from City of Brighton, *supra* note 138, at 2.

140. COLO. CODE REGS. § 604 (2020). The MOU approved by Broomfield in 2017 requires that company to "agree[] to use quieter, state-of-the-art drilling equipment; install[] pipelines to cut back on truck traffic and on-site storage; adher[e] to setbacks that go farther than what state law mandates; and remov[e] old wells and storage tanks in neighborhoods on both sides of the county line." John Aguilar, *Broomfield Approves Oil and Gas Deal After Knock-Down, Drag-Out Fight*, DENVER POST, https://www.denverpost.com/2017/10/24/extraction-oil-gas-drilling-memorandum-broomfield-city-council-meeting/ (last updated Oct. 25, 2017, 11:48 AM).

141. For sources questioning whether MOU terms are or will be enforced by state regulators, see Shaffer et al., *supra* note 135, at 72 n.13; Skylar Zilliox & Jessica M. Smith, *Supraregulatory Agreements and Unconventional Energy Development: Learning from Citizen Concerns, Enforceability and Participation in Colorado*, EXTRACTIVE INDUSTRIES AND SOC'Y 69, 72 (2016).

142. Industry groups at this point do not dispute MOU's enforceability. *Cf. Anatomy of an MOU*, INTERMOUNTAIN OIL AND GAS BMP PROJECT, https://www.oilandgasbmps.org/resources/MOU-anatomy.php (noting enforcement provisions within MOUs between industry and local governments in Colorado) (last visited Apr. 15, 2020). The same issues have been raised with respect to Community Benefits Agreements entered into by developers to facilitate redevelopment plans.

143. Skylar Zilliox & Jessica M Smith, *Colorado's Fracking Debates: Citizen Science, Conflict and Collaboration*, 27 SCI. AS CULTURE 221, 237–39 (2018); Zilliox & Smith, *supra* note 141, at 71.

governance solution to a commons problem.[144] Notably, MOUs are not perpetual: some localities already are in their second iteration of MOUs, and, over time, MOUs may come to address more aspects of the neighborhood quality externality and do so in more effective and (for industry) less expensive ways.[145]

Colorado's MOUs provide an example of how technological innovation—in this case, in oil and gas extraction—can facilitate institutional innovation. Impact benefit agreements, which often include environmental management provisions, have been used outside the United States by the mining industry and largely in connection with indigenous or aboriginal communities with legal claims to resources under treaty or other law. In the context of agreements with First Nations in Canada at least, these MOUs do purport to be binding contracts.[146] In the United States, community benefit agreements have been commonly used in connection with large-scale urban real estate developments, but these agreements do not purport to govern technical aspects of an extractive operation, and they typically are understood to have limited duration.[147] MOUs in Colorado are thus an innovation for the oil and gas industry in the United States and, indeed, for domestic extractive industries generally. In their regulation by binding contract of an ongoing, essentially industrial activity, they represent a distinctive form of governance in response to growing externalities.

3. Texas

The fracking boom began in Texas before it did elsewhere—indeed, it is where the combination of slick water fracturing and horizontal drilling that triggered the nationwide boom was first perfected.[148] There has, as a result, been more time for the legal system to adapt to intensive resource use and the associated externalities. One of those externalities—the neighborhood quality externality—has been especially prominent in Texas because so much drilling and fracking has focused on the populated Fort Worth metropolitan area, which is at the heart of the Barnett Shale play. Between 2005 and 2010, over 12,000 wells were drilled in that area,[149] and there are currently nearly 2,000 active wells within the city limits.[150] Stories abound of wells pressing up against

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144. Smith, *supra* note 5, at 294.

145. *See* Skylar Zilliox & Jessica M. Smith, *Memorandums of Understanding and Public Trust in Local Government for Colorado's Unconventional Energy Industry*, 107 ENERGY POL'Y 72, 79 (2017).

146. *See, e.g.*, Nelson Bennett, LNG Canada Sets Examples, Says First Nations Leader, May 29, 2019, JWN Energy, https://www.jwnenergy.com/article/2019/5/lng-canada-sets-example-says-first-nations-leader/ (describing a binding contract in the liquefied natural gas terminal context).

147. Patricia E. Salkin, *Understanding Community Benefit Agreements: Opportunities and Traps for Developers, Municipalities and Community Organizations*, https://community-wealth.org/sites/clone.community-wealth.org/files/downloads/article-salkin.pdf; *see also* van de Biezenbos, *supra* note 136, at 593–94 (comparing Colorado's MOUs to other forms of industry agreements with local communities).

148. *See* Golden & Wiseman, *supra* note 12, at 974–75.

149. *High Benzene Levels Found on Barnett Shale*, DALL. MORNING NEWS (Jan. 28, 2010, 9:17 AM), https://www.dallasnews.com/news/texas/2010/01/28/High-benzene-levels-found-on-Barnett-3021.

150. *See City of Fort Worth Gas Well Status February 2018*, *supra* note 21 and accompanying text.

residences, sandwiched into lots bordering schools.[151] Although populated areas of Texas are familiar with conventional drilling in their backyards,[152] the current intense push for drilling in essentially urban and suburban areas has no precedent. And residents have taken notice, of course, complaining about essentially industrial operations and their possible adverse effects close to where they live and work.[153]

Demsetz's theory would suggest that the rise of urban and suburban drilling in Texas would lead to a greater specification of the relative rights of owners of fracking operations and owners of nearby parcels. And, in fact, this has proven true, with neighbors claiming rights in the form of local regulation.[154] As in Pennsylvania and Colorado, however, this specification has hardly been linear. As discussed below, localities sought to unilaterally specify limits on fracking operators' rights and did so to a large extent, and then the Texas legislature in turn restricted the scope of local discretion in specifying the rights of fracking operators.[155] In contrast with Pennsylvania, and contrary to Demsetz's theory, the overall result of the rights specification has not been to force the internalization of fracking's external costs so much as to assure operators that they can continue to impose external costs in the form of reduced neighborhood quality.

Texas legal institutions, notably the legislature and courts, have long supported the oil and gas industry, which undergirds the Texas economy to a very substantial degree.[156] At the same time, Texas is also a state that confers home rule authority on communities larger than 5000 residents,[157] and that has a legal tradition of empowering localities with substantial authority over local land use. Prior to the fracking boom, localities were reasonably successful in litigation against the oil and gas industry.[158] Thus, prior to the explosion of

151. *See supra* note 23 and accompanying text.

152. Tysco Oil Co. v. R.R. Comm'n of Tex., 12 F. Supp. 195, 197 (S.D. Tex. 1935) (describing wells in Houston and local regulation of those wells).

153. See *supra* note 23 and accompanying text.

154. Many local governments in Texas have lengthy ordinances that address drilling and fracking. *See, e.g.*, FORT WORTH, TEX., CODE OF ORDINANCES, ch. 15 (2014); Flower Mound, Tex. Ordinance No. 29-11 (July 18, 2011); Flower Mound, Tex., Ordinance No. 36-11 (Aug. 1, 2011); Arlington, Tex., Ordinance No. 19-031 (May 21, 2019).

155. However, Texas "grandfathered in" local governments that had regulated the industry for at least five years without overly impeding development. TEX. NAT. RES. CODE ANN. § 81.0523(d) (West 2015).

156. *See* Davis, *supra* note 109, at 182 (observing that oil and gas industry businesses accounted for twenty percent of Texas's economy in 2012).

157. TEX. CONST. art. XI, § 5.

158. *See, e.g.*, City of Mont Belvieu v. Enter. Prod. Operating, 222 S.W.3d 515, 521 (Tex. Ct. App. 2007) (holding that local ordinance regulating drilling in connection with an underground salt-dome hydrocarbon storage facility was not preempted by Texas state law); Klepak v. Humble Oil & Ref. Co., 177 S.W.2d 215, 218 (Tex. Ct. App. 1944) (affirming the legality of the City of Tomball's Oil and Gas regulation); David J. Klein, *Home Sweet Home: Clarifying and Reinforcing a Municipality's Authority to Regulate Natural Gas Activities in Its Corporate Limits*, 14 TEX. TECH ADMIN. L.J. 339, 355 (arguing, before House Bill 40, that Texas law preferred co-regulation of natural gas production by the state and locality). *See generally* Bruce M. Kramer, *Local Land Use Regulation of Extractive Industries: Evolving Judicial and Regulatory Approaches*, 14 UCLA

fracking in populated North Texas, it was unclear how much localities could regulate—and even regulate to the point of banning—fracking under Texas law.

As fracking boomed, localities responded by promulgating detailed ordinances addressing everything from mandatory environmental liability insurance to the use of closed tanks for waste storage.[159] They also established laws that required far greater setbacks between new wells and residences, high-occupancy building and waterways than the state required. For example, the City of Flower Mound in North Texas enacted a 1500 foot setback requirement in 2011.[160] These substantial setbacks were perceived to be de facto attempts to ban new fracked wells,[161] but the legality of a ban on fracking became a focal point of State politics only after Denton—a North Texas city in the heart of the Barnett Shale play—enacted a ban on new wells through voter initiative.[162] The state's General Land Office and oil and gas industry members sued Denton, arguing the ban violated Texas law.[163] But before the litigation had resolved the issue (or even produced a court opinion), the Texas legislature passed House Bill 40, which Governor Abbott signed into law.[164] The law, which was co-authored and co-sponsored by Democrats as well as Republicans,[165] largely shifted the balance of rights between operators and neighbors to the benefit of the operators.

House Bill 40 is clear about one thing: it prohibits local bans on fracking. It also substantially restricts local fracking regulations. The law expressly limits municipalities' ability to regulate surface activity of oil and gas operations, such as setbacks and light, noise, and traffic related to fracking operations, to local regulations that do not effectively prohibit any operations, are not otherwise preempted by state or federal law, and are "commercially reasonable."[166] The statute defines the key term "commercially reasonable" in a very industry-friendly way: as "a condition that permits a reasonably prudent operator to fully, effectively, and economically exploit, develop, produce, process, and transport oil and gas."[167] While "commercially reasonable" obviously can be subject to

J. ENVTL L. & POL'Y 41 (1996) (describing courts' historic treatment of local regulation of fossil fuel extraction and mining).

159. *See supra* note 154 and accompanying text.

160. *See* Flower Mound, Tex. Ordinance No. 29-11 (July 18, 2011).

161. *See, e.g.*, Steve Everley, *"Setbacks" Really an Attempt to Ban Drilling*, SAN ANTONIO REG. (Apr. 19, 2015, 12:00 AM), https://www.mysanantonio.com/opinion/commentary/article/Setbacks-really-an-attempt-to-ban-drilling-6207480.php.

162. Mose Buchele, *After HB 40, What's Next for Local Drilling Rules in Texas?*, NAT'L PUB. RADIO (July 2, 2015, 8:58 AM), https://stateimpact.npr.org/texas/2015/07/02/after-hb-40-whats-next-for-local-drilling-bans-in-texas/.

163. Plaintiff's Original Petition and Application for Permanent Injunction, Patterson v. City of Denton, No. D-1-GN-14-004628, 2014 WL 5809895, at *1 (D. Tex. Nov. 5, 2014).

164. Tex. H.B. 40 § 2, 84th Leg. (Tex. 2015) (codified at TEX. NAT. RES. CODE ANN. § 81.0523 (West 2020)).

165. *Id.*

166. TEX. NAT. RES. CODE ANN. § 81.0523(a)(1).

167. *Id.*

different interpretations, as some municipal officials have emphasized,[168] the statute's definition seems to suggest that any regulation that significantly infringes upon the profitable operation of fracking operations will be legally vulnerable.

While the law specifies property rights in favor of industry, it also specifies some locality rights.[169] Such specified rights, however, leave out localities that have not yet enacted protective regulation and any new regulation meant to address new understanding of the risks from fracking. As a compromise to municipalities, H.B. 40 was amended prior to its passage to provide that any ordinances that have been in effect for at least five years and that have "allowed the oil and gas operations at issue to continue during that period" are to be "considered prima facie to be 'commercially reasonable.'"[170] This provision falls short of genuine grandfathering, as industry can still challenge pre-enactment regulations and, notwithstanding the "prima facie" presumption, the same definition of commercially reasonable applies in challenges to pre-enactment ordinances as to post-enactment ones.

The Texas story deviates from the Demsetz theory in that the specification of property rights in the wake of conflict over intensified resource use did not compel the internalization of costs generated by the intensified resource use. House Bill 40, overall, had as its primary goal and anticipated effect *limiting* the extent to which fracking operators must internalize costs so as to reduce or eliminate the neighborhood quality externality associated with fracking. The statute thus seems to move the legal status quo in the opposite direction from that projected by Demsetz.

The states' varied responses to greater neighborhood amenity externalities show the messy factors that complicate a Demsetzian framework. Politics, courts, and residents' experience with past oil and gas operations, among other factors, enhance or decrease the likelihood that greater property rights or institutional innovations will emerge in response to externalities. The water supply and water quality externalities show even more divergence from the Demsetz story due to similar factors, as we explore below.

B. Water Supply and Quality

As discussed in Part I, the type of fracking now applied to shales around the United States uses large quantities of fresh water and generates waste that can, in turn, endanger the quality of fresh water. The water quantity externality, in particular, would seem to induce a classic Demsetzian response of enhanced definition of property rights with scarcity. Indeed, Demsetz used water as an example in his original work developing his theory, noting that a conversion of

168. *See* Melanie Kemp Okon & Susan E. Hannagan, *HB 40: Impact on Municipal Regulation of Oil & Gas Operations*, DALL. BAR ASS'N, Feb. 22, 2016 (suggesting that the bill will produce "extremely fact-intensive" litigation).

169. TEX. NAT. RES. CODE ANN. § 81.0523(c).

170. *Id.* at § 81.0523(a).

water rights from communal to private rights would benefit individual users, potentially encourage the internalization of more benefits and costs of water use, and reduce the costs of negotiating to lower the collective externalities of private resource use.[171] And a substantial body of literature has applied the theory to water rights regimes, exploring the extent to which the development of water law comports with the Demsetz thesis or aspects of it.[172]

The combination of concerns about water scarcity and the availability of a convenient alternative—reuse and recycling—would seem to trigger both water quantity and quality-related Demsetzian responses. We would project that particularly in dry states, where water resources are scarcer and traditional waste disposal outlets are also increasingly limited, governance would change to require reuse and recycling of produced water and flowback. But as we explore here, in Texas and Colorado—the more arid states, as compared to Pennsylvania—fracking and associated water scarcity has not led to greater definition of property rights in the resource or innovative tools to manage a largely communal resource. This may be, in part, because scarcity associated with fracking has in many cases not affected other human users of water but rather the species that depend on it—an externality that goes unnoticed by many. And, with respect to wastewater disposal and associated water quality concerns, operators in Texas, in particular, have simply sought out more convenient outlets for disposal rather than more closely defined and guarded property rights in existing disposal methods.[173] In Pennsylvania, scarcity of oil and gas waste disposal options appears to have generated both enhanced definition of property rights through regulation and operator innovation in the form of wastewater recycling.[174]

1. Pennsylvania

As with the neighborhood amenity externality and water quantity, Pennsylvania's response to greater risk to water quantity and quality as fracking expanded tracks the Demsetzian theory most closely of our three case study states.

171. Demsetz, *supra* note 1, at 356–57.

172. *See, e.g.*, Carol M. Rose, *Energy and Efficiency in the Realignment of Common-Law Water Rights*, 19 J. LEGAL STUD. 261, 262, 293–95 (1990); Henry E. Smith, *Governing Water: The Semicommons of Fluid Property Rights*, 50 ARIZ. L. REV. 445, 452–56 (2008) (noting how water regimes depart in substantial ways from the theory).

173. *See* James Osborne, *EPA Weighs Allowing Oil Companies to Pump Wastewater into Rivers, Streams*, HOUS. CHRON. (Oct. 15, 2018, 2:02 PM), https://www.houstonchronicle.com/business/energy/article/EPA-weighs-allowing-oil-companies-to-pump-13303676.php (seeking more lax surface water regulation).

174. *See Pennsylvania Underground Injection Control (UIC) Permits*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/uic/pennsylvania-underground-injection-control-uic-permits (last visited Apr. 15, 2020) (showing that the EPA has recently issued more UIC permits in Pennsylvania).

a. *Water Supply*

Pennsylvania has more abundant water supplies than Texas or Colorado, although it, too, experiences periods of drought.[175] And the numerous surface and groundwater sources of water in the state also arguably make water quality concerns more intense. Streams and other waters that support important aquatic species abound, and some pollution incidents from fracking wastes, have raised alarm about impacts to aquatic habitats in the state.[176] Further, the presence of numerous private drinking water wells, for which the quality of construction is not regulated by the state, heightens concerns about pollutants seeping into the wells and impacting water quality.[177]

Pennsylvania has a complex water law regime because the state has both a riparian system in the west, which was largely unregulated until 2012, and a relatively strictly-regulated riparian system in the east.[178] The eastern regulated portion provides a strong example of how governance and other commons management approaches can emerge to address increasing competition over a scarce common resource, whereas the west involves a more complex story.

The eastern portion of Pennsylvania falls within the watersheds of the Delaware and Susquehanna Rivers, both of which are governed by somewhat unusual regional agencies that regulate on a watershed level.[179] These agencies are unusual in at least two respects. First, they are formed by interstate compacts; after years of lawsuits among the states that share these rivers, Congress approved the Delaware River Basin Compact and Susquehanna River Basin Compact (SRBC) in which representatives from each state combined forces to form a regulatory body designed to manage water quality and quantity in ways that would avoid these types of legal disputes.[180] Second, and relatedly, these bodies are unusual in that they govern based on ecological rather than geographic boundaries. Their jurisdiction expressly covers the rivers themselves and their surrounding "watersheds"—the land area over which precipitation and other water flows and eventually enters the large, central river (the Susquehanna or Delaware).

The Susquehanna River Basin Commission, in particular, changed its rules to more clearly specify property rights as fracking boomed in the region. The

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175. *See, e.g.*, RICHENDERFER ET AL., *supra* note 36, at 47 (noting protections implemented by a regional water regulatory agency, including protections in Pennsylvania, during "drought emergencies").

176. *Cf.* Tasker et al., *supra* note 41, at 7083–84 (describing experiments with compounds with chemical concentrations identical to fracking wastewater that killed aquatic life in water).

177. *Recommendations for Construction of Private Water Wells in Bedrock*, PA DEP'T ENVTL. CONSERVATION & NAT. RES., http://www.iconservepa.org/cs/groups/public/documents/document/dcnr_006800.pdf.

178. *See* Craig P. Wilson, Water Resources, in Pennsylvania Bar Institute Resource Manual 189, 189 (2008) (noting that outside of the regulated areas in Pennsylvania, withdrawals or surface or groundwater are only "governed by common law").

179. *Id.*

180. *See* New Jersey v. New York, 347 U.S. 995 (1954) (showing litigation among the basin states that preceded the compacts); *About DRBC*, DEL. RIVER BASIN COMM'N, https://www.state.nj.us/drbc/about/ (last visited Apr. 15, 2020).

Commission updated its rules to require individual permitting of water withdrawals for fracking and to reduce previous quantity-based thresholds that allowed some operators to avoid the permitting requirements.[181] The Commission also actively enforced its existing passby flow requirement, which "is defined as a prescribed streamflow below which withdrawals must cease."[182] In 2011 and 2012, during dry parts of the spring and summer, the Commission suspended water withdrawals—many of which were for fracturing—to protect local stream flows.[183] These withdrawals would have caused streams to drop below the passby flow threshold if they continued.[184] The Commission also worked to install more water quality monitors that provide remote, continuous, real-time data to be placed on a public website, and one member of the oil and gas industry contributed $750,000 to this effort, citing a desire for transparency.[185]

In other parts of the state, where river basin commissions lack jurisdiction, larger water quantity externalities also triggered further definition of property rights. The western part of Pennsylvania previously contrasted sharply with the areas of the Commonwealth that fall within the Delaware and Susquehanna River watersheds. Outside of these watersheds, no regulations applied to water withdrawals; groundwater and surface water withdrawals, with the exception of surface water withdrawals by public water providers, were governed solely by the common law.[186] Thus, operators withdrawing water for fracturing in the western third of Pennsylvania did not, until 2012, need any state authorization for water use and were "limited only by the rights of other riparians and their willingness to challenge the diversion as an unreasonable use damaging their riparian rights."[187] One doctrinal protection that helped to curb a potential free-for-all use of the commons is the courts' outright prohibition against riparian users' transferring their rights or their water to entities who lack property rights

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181. *See, e.g.*, Jim Richenderfer, Water Acquisition for Unconventional Natural Gas Development Within the Susquehanna River Basin, https://www.epa.gov/sites/production/files/documents/richenderfer.pdf (noting a change to require approval by rule of consumptive uses of water for natural gas development, among other changes).

182. *See, e.g.*, RICHENDERFER ET AL., *supra* note 36, at 44, 47 (noting that in individual approvals of water withdrawals for natural gas development, the commission included requirements for maintaining passby flows (stopping water use if the flow of the water source dipped below a certain point) and for "conservation release requirements," which ensure a that a minimum quantity of water is maintained downstream of the water use).

183. *18 Water Withdrawals Remain on Hold to Protect Streams*, SUSQUEHANNA RIVER BASIN COMM'N (Aug. 11, 2011), http://paenvironmentdaily.blogspot.com/2011/08/srbc-18-water-withdrawals-remain-on.html; Press Release, Susquehanna River Basin Comm'n, 37 Water Withdrawals for Natural Gas Drilling and Other Uses Suspended to Protect Streams (June 28, 2012), https://www.srbc.net/about/news/news-release.html?id=89.

184. *See* sources *supra* note 183.

185. RICHENDERFER ET AL., *supra* note 36, at 55; David E. Hess, Susquehanna River Basin Commission *Real-Time Water Quality Data Available No Online*, PA ENVTL. DIG. (Mar. 8, 2010) http://www.paenvironmentdigest.com/newsletter/default.asp?NewsletterArticleID=15054.

186. Wilson, *supra* note 178, at 189.

187. *Id.* at 201.

in riparian lands.[188] But, again, violations of this doctrine required motivated riparian users to raise case-by-case objections in court, and oil and gas operators drilling and fracturing wells on riparian lands could avoid this prohibition.

As oil and gas operators withdrew water from numerous, diffuse small streams in many different communities,[189] streams in this part of the state were overused—to the point of temporarily drying up entirely—as a result of fracturing operations.[190] Pennsylvania policymakers and administrators stepped in to help remedy the situation. Specifically, pursuant to a statutory requirement issued in 2008,[191] the Pennsylvania Department of Environmental Protection (DEP) required oil and gas operators withdrawing water for drilling or fracturing to submit water management plans and obtain approval prior to withdrawing water.[192] Similar to SRBC requirements, the DEP required that operators stop withdrawing water if the source dipped below a specific passby flow and required a "[p]lan for monitoring and reporting of water sources and uses," including measurement of water withdrawals using "continuous-recording devices of flow meters."[193]

In 2013, voluntary industry standards also emerged to address both water use and water quality issues, demonstrating innovation beyond regulatory definition of property rights. Some oil and gas companies operating in Pennsylvania agreed to follow the voluntary measures encouraged by the Center for Responsible Shale Development, one of which is a commitment to recycle ninety percent of wastewater—using wastewater, rather than freshwater, to fracture new wells.[194] This is likely in part because Pennsylvania environmental regulations, promulgated in response to the shale gas boom and concerns about water quality externalities, place strict requirements on the treatment of wastewater from fracturing.[195] These rules encourage recycling as a potentially cheaper option, and operators therefore might have reached the ninety percent mark without this voluntary commitment. But they also might have made this commitment in an effort to better engage with local resource users and their environmental preferences for reducing water use and waste.

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188. Michael Dillon, *Water Scarcity and Hydraulic Fracturing in Pennsylvania: Examining Pennsylvania Water Law and Water Shortage Issues Presented by Natural Gas Operations in the Marcellus Shale*, 84 TEMP. L. REV. 201, 233 (2011) (noting that "a withdrawal made by a riparian gas company for use on nonriparian land would be per se unreasonable" under the court's traditional rule).

189. *See* Austin L. Mitchell et al., *Surface Water Withdrawals for Marcellus Shale Gas Development: Performance of Alternative Regulatory Approaches in the Upper Ohio River Basin*, 47 ENVTL. SCI. & TECH. 12669, 12670 (2013) ("[I]t is likely that more than 85% of the shale gas industry's water use was taken directly or indirectly from surface waters).

190. Dillon, *supra* note 188, at 202.

191. 58 PA. CONS. STAT. ANN. § 3211(m) (West 2012).

192. PA. DEPT. OF ENVTL. PROT., PENNSYLVANIA HYDRAULIC FRACTURING STATE REVIEW 1, 4 (2010), http://www.strongerinc.org/wp-content/uploads/2015/04/PA-HF-Review-Print-Version.pdf (noting the introduction in 2008 of the required water management plan); 25 PA. CODE § 95.10(b) (2020).

193. 25 PA. CODE § 78a.69.

194. CTR. FOR RESP. SHALE DEV., PERFORMANCE STANDARDS (2013), http://www.responsibleshaledevelopment.org/wp-content/uploads/2018/01/Performance-Standards-v.1.5.pdf.

195. 25 PA. CODE § 95.10(b).

b. Wastewater Disposal

Reducing waste was of particular concern to Pennsylvania communities and the state government due to scarcity of disposal options; much of the property rights specification for the water quality externality in Pennsylvania therefore arose, as Demsetz might have predicted, out of necessity. The geology of the state is not conducive to the most common form of wastewater disposal—underground injection control wells,[196] although operators have sought to alleviate scarcity by requesting and obtaining several new injection permits.[197] And fracking operators' initial preferred method of disposing of liquid wastes—public sewage treatment plants—was shut down relatively quickly by the federal EPA.[198] In the meantime, operators in Pennsylvania sought out alternative injection wells in other states, trucking many of their wastes to West Virginia and Ohio.[199] The objective here was to find the cheapest, most convenient means of disposal that required the fewest possible changes to operations and allowed the same level as cost externalization that operators were accustomed to in the wastewater context. But, after Ohio experienced earthquakes determined to be triggered by injection wells, the state began to more heavily regulate the wells and placed a fee on sending waste to the wells.[200] With few options at hand—and with tightening Pennsylvania regulations—operators' disposal options substantially narrowed.

The state modified its regulations to require that fracking wastewater be treated prior to disposal and to mandate that operators develop a plan for how they would reduce the wastewater produced by the drilling and fracking operation.[201] This, along with the limited availability of underground disposal wells, appears to have strongly encouraged wastewater reuse. By some estimates, ninety percent of fracking wastewater in Pennsylvania is reused because treatment and disposal of the water is expensive and relatively burdensome for well operators.[202] But new injection wells are now being permitted in the state as opportunities for reuse and recycling narrow.[203]

c. Surface Discharges and Well Casing Failures

As fracking expanded, Pennsylvania also tightened its regulations designed to address spills of pollutants at the surface and potential casing issues. It

196. *But see supra* note 174 and accompanying text.

197. *See* Veil, *supra* note 49.

198. *See* Effluent Limitations Guidelines and Standards for the Oil and Gas Extraction Point Source Category, *supra* note 55 and accompanying text.

199. VEIL, *supra* note 57, at 41.

200. OHIO REV. CODE ANN. § 1509.22(H)(1)(b) (West 2013) (placing a higher fee on waste generated outside of the jurisdiction of the Ohio Department of Natural Resources).

201. 25 PA. CODE § 95.10(b) (2020).

202. Carlos R. Romo, *Hydraulic Fracturing, Uncooperative Federalism, and Technological Innovation*, J. ENERGY & ENVTL. LAW, Winter 2014, at 1 ("According to some estimates, operators are currently recycling as much as 90% of wastewater in the state").

203. *See* Veil, *supra* note 49.

required greater secondary containment around tanks and larger setbacks between fractured wells or well sites and nearby resources, such as streams and wetlands.[204] The state also implemented a rebuttable presumption that water well contamination near well sites was caused by drilling or other operations. Operators deemed to have contaminated water wells under this standard had to fully replace the impacted water supply; the regulations therefore strongly incentivized operators to perform baseline testing of water quality prior to drilling and fracking so that they could rebut the presumption of contamination.[205] These actions had the effect of cabining operators' ability to externalize the costs of the drilling and fracturing process.

Pennsylvania's and regional water commissions' actions in the areas of water quantity and quality—and, to a more limited degree, operators' voluntary responses—show that this state hewed most closely to the Demsetz model in terms of tightening property rights definitions through governance and developing other innovative methods to respond to expanding externalities in these areas.

2. *Colorado*

Unlike in Pennsylvania, Colorado's water law regime did not change substantially as fracking expanded within the state, and its laws addressing water quality changed only in moderate ways. In the water quantity context this is likely because the state—already highly familiar with water scarcity—had a detailed regulatory regime in place for water rights long before the fracking boom emerged.[206]

a. *Water Quantity*

The overall quantity of new water used for fracking in Colorado pales in comparison to other uses; in 2010 it comprised 0.08% of all demands for water in Colorado.[207] But at a localized level, water scarcity associated with fracking has generated externalities.[208] There simply is not enough water to go around in

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204. 58 PA. CONS. STAT. § 3215 (2012).

205. 58 PA. CONS. STAT. § 3218 (2012).

206. *See, e.g.*, William Fronczak, *Designated Ground Water: Colorado's Unique Way of Administering Its Underground Resources*, 7 U. DENV. WATER L. REV. 111, 111 (2003) ("As ground water within Colorado became increasingly exploited in the late 1940s and early 1950s, the State began taking a closer look at its ground water resources including the ways to manage them."); Ryan Jarvis, *Prior Appropriation and Water Quality: The Water Court's Authority to Protect an Appropriator's Right to Clean Water*, 16 U. DENV. WATER L. REV. 295, 299 (2013) (noting the Water Right Determination and Administration Act of 1969 as "perhaps the most significant development" in Colorado water law).

207. *Water Sources and Demand for Hydraulic Fracturing of Oil and Gas Wells in Colorado from 2010 Through 2015*, COLO. DIV. OF WATER RES., https://www.erieco.gov/DocumentCenter/View/2779/Oil-and-Gas-Water-Sources-Fact-Sheet?bidId=.4 (last visited Apr. 15, 2020).

208. *See, e.g.*, U.S. ENVTL. PROT. AGENCY, CASE STUDY ANALYSIS OF THE IMPACTS OF WATER ACQUISITION FOR HYDRAULIC FRACTURING ON LOCAL WATER AVAILABILITY 3 (2015), https://www.epa.gov/sites/production/files/2015-07/documents/hf_water_acquisition_report_final_6-3-15_508_km.pdf (noting that in Colorado's Piceance basin, for 16% of the days where there were withdrawals

some parts of the state. Despite the rise of localized scarcity issues, water rights in Colorado have not changed substantially with the expansion of water for fracking.[209] The few exceptions include isolated court cases that have further defined and limited property rights in water. For example, prior to the slick water fracking boom in shales and tight sandstones in Colorado, the use of fracking to extract natural gas from coalbed methane formations in the state triggered a court decision making clear that the water that naturally comes up out of the coalbed—produced water—is subject to the state's water law regime.[210] The lack of change is likely because of the existing, relatively stringent regulation of water in the state.

For surface waters and the ground water that connects to them ("tributary waters"), Colorado has a complex, regulated prior appropriation water rights regime in which "first-in-time" users that diverted water for a beneficial use have priority rights to the water, and junior users may not negatively impact these senior users' rights. The regime as it has evolved divides state waters into six categories. All surface waters are governed by a relatively traditional prior appropriation system administered by the Colorado Water Court. Because almost all surface waters are already over-appropriated, new diversions only realistically occur during the few times when there is excess streamflow and thus room for new users.[211] Water markets in Colorado allow for transfers of existing use rights, but there are high transaction costs to these transfers, including difficulty identifying whether there are adequate supplies to be transferred and the need for a Water Court approval of the change in use.[212]

The remaining five categories of water regimes cover groundwater. Some groundwater is within areas defined as "designated basins," areas in which groundwater withdrawals are regulated by the Colorado Ground Water Commission and thirteen Ground Water Management Districts.[213] Most wells in these basins do not include the use of water for oil and gas development as a recognized right, so an operator wanting to purchase water from a well has to get approval from the Water Commission for changing the use right.[214] Next, there is Denver Basin groundwater, which does not count as a "designated" basin but is still specially regulated. Within this basin there is nontributary groundwater, which is not connected to surface water, and, confusingly, "not-

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from a tributary to the Colorado River, cumulative daily withdrawals removed more than 40% of the available water).

209. *See, e.g.*, COLO. CODE REGS. § 404-1 (2014) (showing amendments to the law involving management of oil and gas waste but demonstrating that the regulatory provision allowing reuse and recycling wastewater already existed as of the 2014 amendments).

210. *See* Vance v. Wolfe, 205 P.3d 1165, 1173 (Colo. 2009).

211. *See* COLO. DIV. OF WATER RES., *supra* note 207.

212. *Id.*

213. *What Are Designated Groundwater Basins?*, MARTIN AND WOOD (Nov. 17, 2018), https://www.martinandwood.com/blog/what-are-designated-groundwater-basins; Fronczak, *supra* note 206, at 115.

214. COLO. DIV. OF WATER RES., *supra* note 207, at 7.

nontributary water."[215] For both types of wells, which fall outside of the prior appropriation regime, there are few restrictions on the types of allowed water use, but no more than one percent of the water underlying the land may be withdrawn annually.[216] Finally, for ground water outside of the designated basins and the Denver Basin, there is tributary and nontributary groundwater. Most tributary water—which falls within the prior appropriation legal system—is connected to surface streams that are already over-appropriated.[217] Operators wanting to use this water must complete detailed Augmentation Plans that describe how they will replace the water used.[218] Nontributary waters outside of the Denver Basin also fall outside of the prior appropriation system and are primarily subject only to the restriction of using one percent of the water beneath the property on an annual basis.[219]

This complex regime makes it very difficult for drilling and fracking companies to obtain new water rights or even purchase them from an existing user, since under many of these systems the operator must get approval for changing the beneficial use of water. The operators' response has therefore largely been innovation by necessity. In the Piceance Basin, in the dry, western portion of the state, operators report one hundred percent recycling of flowback water.[220] Although this recycled water does not cover all of their needs—they still obtain some water from streams and groundwater sources[221]—it is an impressive example of innovation.

The response to increased water quality externalities in the state has been a more formal one, with the state forcing operators to internalize certain water quality externalities as fracking has grown. Most of this cost internalization has been through relatively traditional regulation and has not relied on other innovative management strategies, with the modest exception of water quality testing.

b. Wastewater Disposal

In the context of wastewater disposal, which can pollute surface water and groundwater and trigger earthquakes, Colorado's approach has been less dynamic than Pennsylvania's. Unlike Pennsylvania, the state does not require operators to treat wastewater before disposing of it, in part perhaps because Colorado has relatively abundant UIC well space. Thus, the easiest, most common method of disposing of wastes does not present major scarcity issues for operators in Colorado, potentially disincentivizing the more aggressive actions taken by Pennsylvania—a state with very few UIC wells.

215. *Id.*

216. *Id.*; *see also* COLO REV. STAT. § 37-90-102 (2017) (essentially treating both types of water in the Denver Basin identically).

217. COLO. DIV. OF WATER RES., *supra* note 207, at 7.

218. *Id.*

219. *Id.*

220. U.S. ENVTL. PROT. AGENCY, *supra* note 208, at 3.

221. *Id.*

To address potential earthquakes from UIC wells, the state conducts a review prior to approving an injection well to identify historic seismic events and other conditions that might suggest the well could trigger an earthquake.[222] But in a somewhat more innovative move, the state is working with scientists at several universities, as well as the EPA and a consortium of other states, to better understand the causes of induced seismicity.[223] As with Texas, however, the state has not taken relatively comprehensive substantive regulatory steps to lessen the risks of earthquakes. The state has been somewhat more responsive in terms of preventing and addressing potential spills of chemicals, waste, and other substances at the surface and the threat of underground contamination of water, as discussed next.

c. Surface Discharges and Well Casing Failures

With respect to potential spills of fracking chemicals and other wastes at the surface, Colorado narrowed previously loosely-defined property rights in fracking by adding relatively detailed distance-based limits fracking near public water sources. Specifically, as fracking began to increase in Colorado, the state issued new regulations drawing three buffer zones around public water supplies. In the zone closest to the water supply, very few oil and gas activities could occur. In the next zone, more activities were allowed, provided that adequate pollution-preventing measures were followed, and somewhat more activities were permitted in the farther buffer.[224] However, Colorado did not go nearly as far as Pennsylvania in terms of more formally delineating property rights. The state did not establish new requirements for locating fracked wells farther from streams and other resources at the surface, for example. An attempted citizen amendment in 2018 would have mandated some of these setbacks, but it narrowly failed.[225]

To address concerns about potential water contamination from drilling and fracking, in 2013 Colorado revised its policy to require that any oil and gas operators drilling a horizontal well identify and report all existing oil and gas wells within 1500 feet of the proposed horizontal well.[226] This allows the state to pinpoint any wells that have inadequate casing and that could provide a conduit for leaking pollutants. If any existing wells are shown to have casing

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222. *Engineering Unit Seismicity Review for Class II Underground Injection Control Wells*, COLO. OIL & GAS CONSERVATION COMM'N https://cogcc.state.co.us/documents/about/TF_Summaries/GovTaskForceSummary_Sesimicity_Review_for_Class_II_Underground_Injection_Control_Wells.pdf (last visited Apr. 15, 2020).

223. *Id.*

224. COLO. CODE REGS. § 404-1:317B (2014) (showing regulations promulgated in 2007).

225. John Aguilar, *Prop 112 Fails as Voters Say No to Larger Setbacks for Oil and Gas*, DENVER POST, https://www.denverpost.com/2018/11/06/colorado-proposition-112-results/ (last updated Nov. 8, 2018, 8:52 AM).

226. STATE REV. OF OIL AND NAT. GAS ENVTL. REGULATIONS, A REPORT AND SUMMARY OF OUTCOMES FROM 2010–2012 HYDRAULIC FRACTURING STATE REVIEWS 9, https://www.strongerinc.org/wp-content/uploads/2016/10/A-Report-and-Summary-of-Outcomes-from-2010-2012-Hydraulic-Fracturing-State-Reviews.pdf.

problems, the operator must take remedial measures before it can frack the well.[227] The state also later revised its regulations to require all oil and gas operators to test the quality of water in four water wells near proposed fracking sites.[228] This established baseline data about existing pollution, which, in turn, allowed better identification of new pollutants that might have entered water as a result of drilling and fracking. Although this does not directly force operator internalization of costs, it supports other innovative governance measures such as community monitoring of water quality. It also eases the path to court for landowners concerned about contaminated groundwater. By providing baseline data on water quality, it allows plaintiffs to better demonstrate that new pollutants entered the water supply after drilling and fracking if contamination did, in fact, occur.

Aside from the requirement that oil and gas operators repair old leaky wells near well sites prior to fracking, Colorado took few formal substantive measures to force operator internalization of externalities. Unlike Texas, the state did not change its casing requirements for fracked wells to ensure that pressures placed on the well would not compromise casing. A panel of experts that reviewed Colorado's regulations recommended that the state consider certain changes to its casing requirements—including requiring that casing reach a certain depth below groundwater—but the state reviewed existing wells, determined that none had had casing problems, and concluded that revised regulations were therefore not necessary.[229]

3. *Texas*

Texas—which, like Colorado, has historic experience with water scarcity—did not substantially modify property rights in water in response to the fracking boom. Nor did it require practices such as wastewater recycling, which both reduces the need for freshwater supplies and addresses wastewater disposal and associated water quality concerns.[230] The explanation to this general lack of a Demsetzian response once again lies largely in politics. Unlike Colorado, Texas did not have an existing, detailed regime to regulate water used for fracking when fracking expanded in several of the state's shale plays. However, the state did make some meaningful changes to address water quality concerns, including encouraging operator innovation in wastewater reuse by changing liability in this area and updating certain regulations to force certain internalization of potential pollution externalities.

227. *Id.*

228. COLO. CODE REGS. § 609 (2020).

229. STATE REV. OF OIL AND NAT. GAS ENVTL. REGULATIONS, *supra* note 226, at 9.

230. The state did, however, incentivize recycling by changing liability and tax laws relating to the wastewater. *See infra* notes 258–259 and accompanying text.

a. *Water Quantity*

As described in Part I, fracking requires a great deal of freshwater.[231] The water sources for fracking in Texas differ amongst the various shale plays within state boundaries. For example, surface water and groundwater provide approximately equal amounts of water for fracking in the Barnett Shale play in North Texas.[232] Meanwhile, groundwater provides virtually all of the freshwater supply in the Permian Basin area shale play at the eastern edge of Texas and the Eagle Ford shale play in South Texas.[233] While localized surface water depletion from fracking in Texas is possible,[234] fracking's primary risk to water supply is to Texas's underground aquifers: it is with respect to groundwater that the depletion externality is greatest and where Demsetz's theory would suggest a greater specification of rights encouraging cost internalization as a response to fracking. But, in fact, for reasons related to the configuration of its pre-fracking boom legal institutions, doctrines, culture, and the current political might of the oil and gas industry in Texas, we do not see any greater specification of rights or any move to encourage cost internalization.

Both in the near-term and as a long-term matter, fracking would seem to pose a greater risk to freshwater supply in Texas than in either Colorado or Pennsylvania. The Trinity aquifer, "the primary source of groundwater for energy development in the Barnett Shale, and a major municipal water source," is already in a state of "depletion."[235] Fracking's draw on this already-depleted resource is bound to increase. The water supply issues are even more pronounced in the shale plays in southern and western Texas. According to an EPA report, the potential for water quantity and quality impacts due to hydraulic fracturing acquisition appears to be higher in southern and western Texas than in any other of the areas of fracking in the United States.[236] The Permian Basin bordering New Mexico, in particular, is an arid area of "extremely high water stress."[237] Fracking operators in this already water-scarce region use more water

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231. *See supra* notes 31–35 and accompanying text.

232. U.S. ENVTL. PROTECTION AGENCY, *supra* note 26, at 4-6 tbl. 4-1.

233. *Id.*

234. Surface water, which provides the bulk of water used by municipalities and industry in Texas, is governed by a regulated prior appropriation system, with the relevant surface waters fully or over-appropriated. *Id.* at 4–38. To withdraw from a surface water, therefore, a fracking operator would need to obtain a state permit for a specified amount of water, and any rights granted by the permit would be junior to, or limited by, prior appropriators of the surface water at issue. *Id.* Alternatively, fracking operators could only feasibly acquire appropriated water by purchasing it from currently water rights holders, the most likely of which would be municipalities that hold excess or unneeded water rights. *Id.* at 4–23. But, reportedly, fracking operators in Texas mostly have used surface water via new direct withdrawals rather than market purchase. *Id.* at 4–35.

235. Charles F. Mason et al., *The Economics of Shale Gas Development* 16 (Resources for the Future, Discussion Paper No. 14-42, 2015); U.S. ENVTL. PROTECTION AGENCY, *supra* note 26, at 4–30 (explaining that in the Barnett and Haynesville plays, as groundwater demands increase, there is "potential for localized aquifer drawdown" and that "[g]roundwater quality degradation associated with aquifer drawdown" has been documented in aquifers "overlying much of the Barnett play").

236. U.S. ENVTL. PROTECTION AGENCY, *supra* note 26, at 4–24.

237. *Id.* (noting that 87% of the wells in the Permian basin "are in areas of extremely high water stress").

per fractured well than do operators in the five other major shale plays.[238] The Ogallala Aquifer, which lies below much of the Permian basin, "has limited recharge because of the area's lower rainfall and the clay soils that impede water percolation there."[239]

The doctrine of capture largely defined rights to groundwater in Texas before the fracking boom, and still largely defines such rights. Under the capture doctrine, the owner of the surface land may withdraw—that is, capture—as much groundwater as is physically possible to withdraw.[240] Once withdrawn, the surface owner has close-to-absolute rights to the water. The owner can use the water on land he owns or transfer it to others; there is no limitation on what the water is used for or where it is used.[241] The owner need not withdraw, transport, or use the water in a way that is resource-efficient (for example, by minimizing spills or evaporation).[242] Perhaps most notably, capture of groundwater is entirely lawful even if the surface owner's drilling for water has the effect of depleting water deposits under land owned by others, as can easily occur as underground water supplies invariably cross land boundaries.[243]

Because of the absolutist nature of capture doctrine, courts have almost no opportunity within the contours of the doctrine to reduce the risk that fracking operators will withdraw so much groundwater that the near- or long-term ability of other users to access needed water is threatened. Thus, in a pure capture regime, one can imagine a situation in which fracking operations deplete both the oil and gas resources and the groundwater in an area and then close down, such that the economy no longer benefits from fracking, and other water-dependent uses become infeasible.[244]

Nor does there appear to be a possibility that the Texas courts will simply hold that capture is no longer a valid legal rule. If a locality or neighbor sued

238. Kondash et al., *supra* note 32, at 4.

239. *Aquifers*, TEX. A&M U.: TEX. WATER, https://texaswater.tamu.edu/groundwater/aquifers.html (last visited Apr. 15, 2020).

240. For a description of how the Texas doctrine of capture for groundwater originated, its perverse effects, and its durability despite criticism, see Zachary Bray, *Texas Groundwater and Tragically Stable "Crossovers,"* 2014 BYU L. REV. 1283.

241. *See id.* at 1311–14.

242. *See id.* at 1320.

243. *See* Margaret A. Cook et al., *Who Regulates It? Water Policy and Hydraulic Fracturing in Texas*, 6 TEX. WATER J. 45, 50 (2015) (explaining that Texas' capture regime allows unlimited withdrawals "even if [the] . . . withdrawal[s] will inhibit access to water by neighboring landowners"). For example, in *City of Corpus Christi v. City of Pleasanton*, 276 S.W.2d 798 (1955), the Texas Supreme Court upheld a withdrawal of water under the doctrine of capture even though ten million gallons of groundwater was lost per day to evaporation and seepage during transport. In *Pecos City. Water Control & Improvement Dist. v. Williams*, 271 S.W.2d 503 (Tex. Civ. App. 1954), the court allowed irrigators to over pump the aquifer and dry up nearby springs that contributed to surface water flow.

244. The Texas capture regime, in the context of fracking, thus presents a close analogy to Demsetz's overgrazing example, with the important difference that oil and gas, unlike grazing land, is a depletable resource, so industry rationally may take a short-term perspective. *Cf.* 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 (2014) (explaining why fracking operators do not take a long-term view with respect to environmental damage from fracking).

fracking operators for capturing "too much" water, a lower court in Texas (or a federal court, applying Texas law) could do nothing. This is because the Texas Supreme Court in *Sipriano v. Great Spring Waters of America*,[245] while seeming to acknowledge the irrationalities of capture as a rule for allocating water rights, refused to abandon it, resting its decision to do so on tradition, settled expectations, and the court's view of the superiority of the legislature as the institutional nexus for legal reform.[246]

Since 1949, Texas has had a state statute authorizing the creation of groundwater conservation districts.[247] In *Sipriano*, the Texas Supreme Court suggested that the Texas legislature could further empower groundwater conservation districts and, should they choose, could modify the absolutist common law the rule of capture law with regulations without incurring liability for a taking.[248] But the Texas legislature has not enacted a groundwater law post-*Sipriano*, and groundwater conservation districts, as currently constituted, are not well-positioned to address the water supply externality posed by fracking. For one thing, some areas of Texas with fracking activity simply have no conservation district in place.[249] Second, where they have been established, groundwater conservation districts generally correspond to the borders of a county, which do not generally match the boundaries of water resources. And there is a notable lack of consistency and coordination among district regulations within the shale plays in Texas.[250] Third, under Texas law, districts have very little funding flexibility and generally very little funding at all; districts can levy taxes only by means of special elections in which they seek voter approval for specific financial outlays.[251] As a result, the districts are not well-positioned to take on costly political or litigation battles with the extremely well-resourced oil and gas industry.[252]

On top of all this, Texas state law arguably is designed to prevent districts from doing anything with respect to water withdrawals for fracking. Texas' water code was written before fracking, and while it permits groundwater conservation districts to develop a permit program for "drilling, equipping,

245. 1 S.W.3d 75 (Tex. 1999).

246. *Id.* at 80–81.

247. *See Groundwater Conservation Districts*, TEX. A&M U.: TEX. WATER, https://texaswater.tamu.edu/groundwater/groundwater-conservation-districts.html (tracing history of districts).

248. *Sipriano*, 1 S.W.3d at 79.

249. Cook et al., *supra* note 243, at 50.

250. *Id.* at 60. As a general matter, the fact that any given district only includes a portion of the relevant underground aquifer creates a disincentive for districts to engage in conservation regulation, as a district's water supply will not necessarily stabilized by its own restrictions on in-district water withdrawals, and, by the same token, a district can externalize the costs of withdrawals to out-of-district (or as we shall see, out-of-state) water users.

251. TEX. WATER CODE ANN. § 36.201 (West 2020).

252. *See, e.g.*, Carlos Morales, *West Texas Ground Water Districts Scramble to Keep Up with Industry*, MARFA PUB. RADIO (Aug. 21, 2017), http://marfapublicradio.org/blog/west-texas-groundwater-districts-scramble-to-keep-up-with-industry/ (explaining that with very small budgets, ground water districts cannot keep pace with the oil and gas industry).

operating, or completing" wells, it exempts oil and gas exploration wells from permit requirements.[253] Although some districts do not construe the exemption to cover water wells drilled to service fracking, even these districts reportedly have been hesitant to litigate the issue and have settled when faced with litigation threats.[254] Groundwater districts have urged the Texas legislature to clarify the scope of the statutory exemption, and various bills have been introduced. But none have come close to passing.[255]

One alternative to direct regulation of water withdrawals for fracking is to regulate methods of disposing of fracking wastewater—thus incentivizing reuse or recycling of the water in other wells—or to directly require recycling or reuse. But Texas, unlike Pennsylvania, does not require wastewater reduction plans or treatment of most wastewater prior to disposal, as discussed below.[256] And underground injection wells in Texas are abundant; they offer the cheapest option for wastewater management despite freshwater for fracking being relatively scarce.[257] Texas only encourages wastewater recycling through a law that reduces operator liability for any pollution caused by the wastewater after it leaves the well site for treatment,[258] and through tax exemptions for equipment used in recycling.[259] Groundwater conservation districts cannot discourage water withdrawals by restricting the drilling and use of injections wells for wastewater disposal, because the districts lack jurisdiction over disposal wells.[260]

Another problem with the regulatory regime for groundwater in Texas is that some underground water resources cross state borders—most notably the Texas-New Mexico border—and there is no institutional apparatus to address cross-boundary concerns. Fracking recently boomed on both sides of the Texas-

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253. TEX. WATER CODE ANN. § 36.117(b)(2).

254. *See* Bray, *supra* note 240, at 1343; Tiffany Dowell Lashmet & Amber Miller, *Texas Exempt Wells: Where Does Fracking Fit?*, 55 NAT. RES. J. 239, 253–256 (2015).

255. *See, e.g.*, Stacey A. Steinbach, *Legislative Wrap-Up: 83rd Legislative Session*, TEX. ALLIANCE OF GROUNDWATER DISTRICTS, http://www.texasgroundwater.org/pdfs/130730TAGDLegSumWeb.pdf (last visited Apr. 15, 2020) (discussing the failure of S.B. 873, which would have clarified the scope of authority of groundwater districts). The powerful Texas Oil and Gas Association has opposed any statutory efforts to clearly vest permitting authority in groundwater conservation districts. *See* Lashmet & Miller, *supra* note 254, at 255–56.

256. *See infra* Subpart II.B.3.b.

257. Jackie Benton, *Recycling Fracking Water*, COMPTROLLER.TEXAS.GOV.: FISCAL NOTES, https://comptroller.texas.gov/economy/fiscal-notes/2015/october/fracking.php (last visited Apr. 15, 2020).

258. H.B. 2767, 83rd Leg., Reg. Sess. (Tex. 2013). The recycler, rather than the generator of the wastewater, legally owns the water under this law. *Id.* The bill also limits the liability of recyclers after they have transferred the water to another operator for use in a well. *Id.*

259. TEX. TAX CODE ANN. § 151.355 (West 2020); *see also* Alex Brakefield, *Produced Water Management: A Comparative Study*, TEX. J. OIL GAS & ENERGY L. BLOG (Oct. 30, 2016), http://tjogel.org/produced-water-management-a-comparative-study/ (describing Texas's regulatory approach to produced water management and comparing it to Pennsylvania's).

260. Indeed, groundwater conservation districts may not even require fracking operators to notify them of the drilling of new disposal wells. Jim Malewitz, *Groundwater Districts Seek Help Tracking Disposal Wells*, TEX. TRIB. (July 29, 2015, 6:00 AM), https://www.texastribune.org/2015/07/29/groundwater-officials-seek-help-tracking-disposal-/.

New Mexico border, with water captured on the Texas side of the border providing some of the water used for fracking in New Mexico—where there is strict regulation of groundwater withdrawal. According to New Mexico officials, Texans are sucking up water that otherwise would lie underneath New Mexico and then are transporting it for profit to New Mexico, frustrating New Mexico's efforts to address depletion risk.[261] The absence of meaningful groundwater withdrawal regulation in Texas thus spills over to New Mexico.

While state-based water regulation is almost never sensitive to out-of-state effects,[262] Texas also seems to have not dealt with depletion risks to Texas from water withdrawals from fracking. Legal responses to the risk of depletion in Texas have been, in some of the areas most at risk, basically nonexistent, although from a Demsetzian perspective Texas is perhaps the state where we would most anticipate property rights specification and cost internalization regarding water supply would result from the added resource demand associated with fracking.

b. Wastewater Disposal

Texas has experienced a massive increase in wastewater production along with oil and gas output.[263] As production has expanded, the options for disposing of the wastewater from drilling and fracking have narrowed, and concerns about spills of wastewater, fracking chemicals, and other substances at and near well sites have increased. Furthermore, attention to the possibility of groundwater contamination during and after fracking, and from wastewater disposal, has increased. Indeed, during a fifteen-year study period, officials in Texas noted 211 groundwater contamination incidents associated with oil and gas production. Approximately thirty-five percent of these were caused by waste management and disposal issues, and approximately twenty-six percent resulted from discharges during oil and gas production.[264]

Enhanced attention to the water quality externality would, from a Demsetzian perspective, suggest that institutional changes would emerge in the form of regulation that required industry to eliminate or otherwise internalize some negative water quality externalities. Additionally, or alternatively,

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261. *See, e.g.*, Jay Root, *New Mexico Official Says Texas Landowners are "Stealing" Millions of Gallons of Water and Selling It Back for Fracking*, TEX. TRIB. (June 7, 2018, 12:00 AM), https://www.texastribune.org/2018/06/07/texas-landowners-new-mexico-stealing-water-fracking/.

262. In fact, Texas has been litigating for years its claim that New Mexico is appropriating part of Texas's rightful share or the water from the Rio Grande River. Emma Platoff, *Federal Government May Fight Alongside Texas in Water Dispute, U.S. Supreme Court Rules*, TEX. TRIB., https://www.texastribune.org/2018/03/05/federal-government-may-fight-texas-water-dispute-us-supreme-court-rule/ (last updated Mar. 5, 2018, 5:00 PM).

263. *See, e.g.*, Nicot et al., *supra* note 32, at 2469 (noting a five-fold increase in wastewater injection volumes over an approximate ten-year period in fifteen counties in Texas).

264. Scott Kell, *State Oil and Gas Agency Groundwater Investigations and Their Role in Advancing Regulatory Reforms: A Two-State Review: Ohio and Texas*, GROUNDWATER PROT. COUNCIL (2011), http://fracfocus.org/sites/default/files/publications/state_oil__gas_agency_groundwater_investigations_optimized.pdf.

innovative governance might at least encourage this cost internalization. As with water scarcity in Texas, however, there has been only limited movement toward forcing industry to bear more of the costs of pollution. There has been some regulatory response to encourage but not require innovation, as we discuss in this part. Overall, rather than enhancing property rights to resolve disputes surrounding existing disposal options, drillers have sought to decrease scarcity in alternative disposal outlets. Specifically, they have pushed to loosen regulations that limit disposal of oil and gas wastewater into surface waters—an approach that would have fewer transaction costs and direct costs for operators, although potentially more environmental externalities, if successful.

Operators' disposal options in Texas vary in terms of their expense and accessibility. In the eastern United States (east of the 98th meridian, which includes the eastern portion of Texas), federal Clean Water Act regulations prohibit discharging liquid oil and gas wastes into surface waters.[265] A separate Clean Water Act regulation allows limited discharge of produced water west of the 98th meridian, provided the water is discharged into surface waters that will be beneficially used for agriculture or wildlife.[266] This distinction exists because when the EPA initially drafted the regulations it modified them in response to comments from western states requesting that the regulations allow for beneficial reuse of water. Few operators have used this discharge option, however, because treatment is relatively expensive.[267]

Another wastewater disposal outlet, reuse and recycling, can also be expensive, particularly if there are no nearby wells to be fracked. In Texas, as the boom in drilling and fracking produced large quantities of wastewater and increased UIC use, resistance to the use of UIC wells emerged but ultimately did little to slow the practice. One suit by citizens alleged that the state agency permitting UIC wells should, as a result of its enabling state statute, have to consider a variety of environmental and social impacts beyond potential underground water contamination, such as road damage and increased truck traffic, when issuing permits for UIC wells.[268] This suit ultimately failed because the court did not interpret the statute's requirement that the agency consider whether the well was "in the public interest" to include considerations of surface impacts such as traffic safety concerns.[269] And the pollution of Midland's drinking water source with a plume of salty water from a failed UIC well—pollution that the bankrupt UIC operator could not pay to clean up[270]—generally

265. 40 C.F.R. § 435.52 (2020).

266. 40 C.F.R. §§ 435.50, 435.52.

267. Osborne, *supra* note 173.

268. R.R. Comm'n of Tex. v. Tex. Citizens for a Safe Future & Clean Water, 336 S.W.3d 619, 622 (Tex. 2011).

269. *Id.* at 632.

270. City of Midland's Motion for Estimation of Claims for Purposes of Allowance, Voting, and Determining Plan Feasibility, and Request for Determination that Remediation Claim is Entitled to Admin. Expense Priority at 26, *In re* Heritage Consolidated, LLC, Nos. 10-36484-HDH-11, 2012 WL 1123145 (Bankr. N.D. Tex. 2012).

raised surprisingly few alarm bells about UIC wells. Texas, did, however, intervene in the suit and seek contributions for the billions of dollars in damage caused.[271] Further, Texas agencies responded relatively slowly to the news that UIC wells were triggering earthquakes, including earthquakes near a major airport in Dallas.[272] The state did ultimately issue revised regulations to address the earthquake risk,[273] but these were minor—primarily requiring information disclosure—compared to new regulations in states like Ohio.[274]

Although there has not been movement to better define property rights through regulation in the UIC context, UIC scarcity has forced an industry response. Particularly with the most recent Wolf Camp Shale boom, UIC space for waste from fracked wells is increasingly scarce. Industry has responded, in part, by seeking alternative, more abundant space for disposal. Operators have supported a Trump Administration EPA move to reconsider existing regulatory restrictions on discharging treated liquid oil and gas wastes directly into surface waters.[275] These regulations would apply throughout the United States, and thus would benefit operators in Texas and elsewhere. But they would be particularly beneficial in Texas given the increasing scarcity of UIC space. In seeking to modify these regulations, operators are, it appears, seeking to skirt what might otherwise be a predictable Demsetzian response: with less UIC space, the state might tighten up UIC requirements or force operators to use alternative disposal methods, thus making operators internalize the rising costs of disposal. Instead, operators are seeking to continue to externalize costs by finding an easy disposal pathway with few restrictions—one that would allow them to dump waste into rivers and streams without requiring them to first apply rigorous treatment that would remove pollutants.

Requiring recycling and reuse of wastewater rather than the use of UIC wells or surface water disposal would be one alternative to this cost externalization by operators. Here, the state has not forced industry to internalize environmental costs of disposal because it has not required recycling, unlike Pennsylvania, which essentially has. But some innovative governance has emerged. As introduced earlier, the Texas Legislature has made recycling of wastes easier by reducing operator liability for the waste.[276] Specifically, after an operator transfers liquid oil and gas wastes to a facility for treatment or another well, the wastes become the property of the entity in possession of

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271. *Id.*; Response of the Tex. R.R. Comm'n to the City if Midland's Motion for Estimation of Claims at 2, *Heritage*, 2012 WL 1123145 (agreeing largely with Midland but noting other potential remediation needs, among other differences).

272. Frohlich et al., *supra* note 53, at 327. Texas promulgated regulations to address induce seismicity that did not take effect until 2014. 16 TEX. ADMIN. CODE §§ 3.9, 3.46 (2020).

273. 16 TEX. ADMIN. CODE § 3.9 (requiring information on historic seismic events around areas proposed for UIC wells and allowing the Railroad Commission, which approves UIC wells, to require more data).

274. OHIO ADMIN. CODE 1501:9-3-07 (2020) (requiring continuous monitoring of injection well pressures and well shut-down if pressures exceed a certain amount).

275. Osborne, *supra* note 173.

276. *See supra* notes 258–259 and accompanying text.

them.[277] And liability for anyone possessing the wastewater is capped.[278] In 2006, as the number of Barnett Shale fracked wells continued to increase, the state also created specific regulations for commercial facilities that recycle wastes from wells, requiring a permit for transporting waste and operating a recycling facility and data to show that the facility will not contribute to water contamination, among other externalities.[279]

As with water use, Texas—the state in which operators generate the most oil and gas wastewater[280]—has again responded to scarcity of wastewater disposal space in ways that do not fit within the traditional Demsetzian framework. The search for environmental resources that offer more abundant disposal options, however, is predictable. If the EPA were to relax current restrictions on the disposal of oil and gas wastes into rivers and streams, this would move surface waters closer to the status of an open access commons. This, too, of course, could perhaps trigger a Demsetzian response as competition for this newly accessible resource tightened. But for now, seeking laxer environmental regulation appears to be operators' preferred course of action.

c. Surface Discharges and Well Casing Failures

Just as water quality risks posed by wastewater disposal have not generated much of a response toward cost internalization by industry, other water quality externalities—groundwater pollution from spills of substances on the surface and faulty casing that leaks—have not in most cases led Texas to promulgate more stringent regulation.

Unlike Pennsylvania, which increased required setbacks of wells from natural resources (in part to prevent spills from reaching those resources),[281] among other requirements, Texas did not revise its regulations to address potential surface discharges. Colorado and Pennsylvania enhanced reporting requirements for spills and discharges, requiring mandatory disclosure of these incidents by operators, whereas Texas has not followed suit.[282] As with the lack of permits for fracking water withdrawals in Texas, difficult-to-access information about spills and discharges means the public might be less aware of the water quality externalities of fracking, and thus might have more difficulty supporting political arguments to enhance regulation.

With respect to the potential for well casing to fail, allowing substances to be released underground, the fracturing boom did trigger regulatory change in Texas. In 2013, the state's oil and gas regulatory agency adopted new casing

277. TEX. NAT. RES. CODE ANN. § 122.002 (West 2020).

278. *Id.* at § 122.003.

279. Kell, *supra* note 264, at 81.

280. VEIL, *supra* note 57, at 37.

281. Act No. 13 of 2012, H.B. 3048, Gen. Assemb., 2011 Sess. (Pa. 2011) (codified as amended at 58 PA. CONS. STAT. § 3215(b)(4) (2020)).

282. Lauren A. Patterson et al., *Unconventional Oil and Gas Spills: Risks, Mitigation Priorities, and State Reporting Requirements*, 51 ENVTL. SCI. & TECH. 2563, 2565 (2017).

regulations designed to ensure that increased pressure placed on the casing by fracking would not contribute to casing failure.[283]

In sum, the case of fracking's water supply and quality externality in Texas suggests that path dependence coupled with current political realities can overwhelm the logic of Demsetz's theory. Texas is, in parts, a very dry state with over-taxed groundwater resources. The additional and—on a localized level—great water demand attributable to fracking operators has commanded attention and calls of alarm, but not enough to override the weight of history and current political realities discussed in Part III.

III. DEMSETZ, PROPERTY RIGHTS, AND GOVERNANCE: UNDERSTANDING MIXED RESPONSES TO GREATER EXTERNALITIES

Fracking would seem to present the classic Demsetz case. A vast resource long assumed to be relatively useless suddenly becomes highly sought-after and valuable. Specifically, shales and similar formations contained vast reserves of oil and gas long assumed to be inaccessible. But the development of the slick water fracking technique, combined with horizontal drilling, represented a technological breakthrough that opened up access to the resource and made it incredibly valuable. As oil and gas companies scrambled to extract the oil and gas, externalities increased and became much more visible, and the gains from developing a regime that specifies rights and addresses externalities should have come to outweigh the transaction costs of developing such a regime. But Part II demonstrates that responses to the fracking boom in different parts of the United States were in fact highly divergent, and often loosely tracked the modified Demsetz theory, if at all.

The differences in the legal treatment of fracking among the states do not seem to be obviously related to differences in geology, hydrology, economics, or even demographics. Instead, the differences in legal treatment seem to be due to variations among the states' pre-fracking-boom legal institutions, politics, and court culture. We begin this Part by describing the several ways in which the state case studies in Part II do not comfortably fit with the Demsetz theory and then flesh out political, legal institutional, and other factors that explain this conundrum.

A. THE DEMSETZ CONUNDRUM

Fracking in populated areas raised the question of the relative rights of fracking operators to maximize revenue from the oil and gas resource and the rights of neighbors, as represented by local governments, to protect their neighborhood quality from fracking's externalities. As the Demsetz framework would suggest, the fracking-neighborhood conflict did result in a new

283. *Summary of Amendments to Statewide Rule 13*, RAILROAD COMM'N OF TEX. (May 24, 2013), http://www.rrc.state.tx.us/oil-gas/compliance-enforcement/rule-13-geologic-formation-info/summary-of-amendments-to-swr-13/; 16 TEX. ADMIN. CODE § 3.13(a)(7) (2020).

specification of frackers' and neighbors' relative rights in Pennsylvania, Colorado, and Texas. In none of the states did the law simply remain unaffected by fracking. Some of the differences among the states are not necessarily inconsistent with Demsetz. The actors and institutions driving the specification of rights differ from state to state; in the neighborhood quality context contracts between fracking entities and localities in Colorado have assumed a large role; in Pennsylvania, the state supreme court's interpretation of the state constitution has been key; and in Texas, it is the state legislature that so far that has specified the rights of fracking entities vis-a-vis localities. Moreover, although all the post-boom specifications of rights entail some uncertainty as to the future legal regime for fracking, the level of uncertainty in Colorado seems greatest. Relatedly, perhaps, Colorado is the only state in which the specification took the form of innovative governance, in the form of MOUs.

According to Demestz's thesis, the specifications in each state should operate so as to encourage the internalization of fracking's neighborhood quality costs. And, indeed, one could characterize the legal developments in Pennsylvania and (to some extent) Colorado as fostering the internalization of such costs by fracking entities. But the 2014 law in Texas seems to be designed to do quite the opposite by allowing cost externalization to neighbors. To state the point in the terms of Demsetz, what we observe in Texas is akin to ranchers in an area, faced with the risk of overgrazing, repealing whatever minimal restrictions they had in place on grazing and explicitly adopting a graze-as-much-as-you-can approach.

With respect to water quality and quantity, all of the states changed their laws addressing water quality to some extent, with Texas modifying its well casing laws, Colorado adding buffer requirements around public drinking water supplies and water quality testing mandates, and Pennsylvania more thoroughly revising its regulatory regime.[284] But particularly for issues such as water quantity in Texas—where water rights disputes were prevalent even before the rise of another water-using industry—the lack of substantial response seems surprising. And for water quality, particularly for highly sensitive issues such as protecting the quality of drinking water, one might have expected even more of a response in Colorado and Texas.

B. Legislative and Regulatory Politics

Much of the Pennsylvania neighborhood quality story, although generally supportive of the Demsetz theory, highlights the extent to which raw political contingencies can drive outcomes to either result in, or not result in, greater internalization of costs that accompany intensified resource use. A Republican governor was in office when the 2012 oil and gas law was enacted, but a Democrat preceded and followed that governor in office. This law expressly required local governments to allow oil and gas development in all zoning

284. *Supra* Part II.

districts—an unabashed attempt to encourage the industry to operate in Pennsylvania.[285] Although it included a suite of state-level environmental restrictions, including increased setbacks between wells and environmental resources, many deemed these to be inadequate to address the externalities of fracking. If a Democrat had been in office in 2012, he or she might well have vetoed a bill seemingly as one-sided as the 2012 law.

In Colorado, politics have also mattered, and specifically political uncertainty. Colorado courts have limited the role of localities in regulating fracking, but they certainly have not held that the Colorado Constitution would bar either a new state law further curtailing or broadly increasing the regulatory power of localities vis-à-vis fracking. Indeed in 2019, Senate Bill 181 could be reasonably described as substantially expanding local control over oil and gas development.[286] And Colorado state politics, with its mix of powerful extractive-industries and also a large environmentalist constituency, could conceivably (and did, in 2019) turn sharply in favor of local control over oil and gas operations. It was not the free market that generated the governance innovation of MOUs between local governments and industry, but, it seems, instead the fact that the wide range of conceivable political outcomes at the state level incentivized contractual compromise solutions to the problem of neighborhood quality externalities.

Politics, too, likely explains much of the deviation from the Demsetz story in Texas, with respect to neighborhood quality, water quantity, and water quality. In Texas state politics, the oil and gas industry has a very long and (substantially) bipartisan tradition of dominance, in part because of history and culture, and in part because of the industry's centrality to the state economy.[287] Among other things, the industry is a powerhouse source of political campaign contributions. In Colorado and Pennsylvania, the industry also has substantial power, but that support is more limited to the Republican party than in Texas, and the Republican party in those states is far less dominant than it is in Texas.

The sheer power of the oil and gas industry at the local government level in Texas also helps explain the low or non-response to the risk of groundwater depletion. The decentralized Texas groundwater conservation district system in effect means that, in those Texas counties where the oil and gas industry is politically strong and the regulation-averse Republican party dominates, a groundwater district will be inclined to be quite solicitous to the desires of the oil and gas industry. That includes almost all Texas counties, including those in the parched Permian Basin, where fracking is most obviously risking localized groundwater depletion.[288]

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285. *See supra* text accompanying note 92.

286. *See supra* notes 116–118 and accompanying text.

287. Davis, *supra* note 109, at 182.

288. *See* Ross Ramey, *Analysis: The Blue Dots in Texas' Red Political Sea*, TEX. TRIB. (Nov. 11, 2016, 12:00 AM), https://www.texastribune.org/2016/11/11/analysis-blue-dots-texas-red-political-sea/ (illustrating Republican domination of Texas).

That power also has been evident at the state level in Texas. As noted in Part II, bills that would clearly classify water wells for fracking as not exempt from groundwater district permitting have not gone anywhere in Texas' Republican-dominated legislature and, if they did, a Republican governor might well veto them. The political power of the oil and gas industry also can be seen in the sidelining of the Texas Department of Environmental Quality regarding fracking and the vesting of complete regulatory jurisdiction in the industry-friendly Railroad Commission, which has been hesitant to require water recycling by fracking operators on the scale required to mitigate the demands fracking places on groundwater supply.[289]

C. Judicial Politics and Legal Culture

Just as legislative and regulatory politics and the influence of the oil and gas industry in the legislative process explains much of the deviation from the Demsetz story, so, too, might the politics of courts and legal tradition. In Pennsylvania, when the state enacted a law essentially requiring local governments to welcome fracking, the fact that the state supreme court struck down this law under a rarely used and extremely vague constitutional amendment might have been one of happenstance. If the political process for appointing and retaining justices on the Pennsylvania Supreme Court happened to have produced a court with a majority that was strongly oriented toward protecting industry, the 2014 *Robinson* decision might have been four-two in favor of upholding the 2012 statute rather than four-two in favor of striking it as unconstitutional.

Unlike Pennsylvania, Texas has no environmental rights amendment in its constitution, and, even if it did, it is difficult to imagine the Texas Supreme Court invalidating an express preemption statute that was designed to foster the continued prosperity of the oil and gas industry in the state. Texas is one of eight states in which Supreme Court judges are elected in explicitly partisan elections, although a justice can be appointed by the Governor when there is a vacancy and serve until the next election.[290] All of the recent and current justices on the Texas Supreme Court are Republicans.[291] Given their party affiliation and connection to partisan politics, it would be surprising to see the Texas Supreme Court adopt a position sharply at odds with the Republican establishment in the state.

Moreover, the legal culture of Texas courts makes it unsurprising that the Texas Supreme Court has refused and, we predict, will continue to refuse to jettison the rule of capture in the context of water quantity—a rule highly solicitous to water users, regardless of how much they use. After all, it was the

289. For a review and critique of the Railway Commission's approach to water recycling, see Lauren Jaynes, *The Effectiveness of Water Recycling Efforts by the Texas Railroad Commission*, 67 Baylor L. Rev. 300 (2015).

290. Emma Platoff, *In Campaigns for Texas' Top Courts, Judicial Candidates Must Rely on Party ID*, Tex. Trib. (Oct. 29, 2018, 12:00 AM), https://www.texastribune.org/2018/10/29/texas-supreme-court-election-2018-court-of-criminal-appeals/.

291. *Id.*

Texas Supreme Court that established the capture rule for groundwater in 1905 in the first place, and that subsequently declined to discard it a number of subsequent cases that could have been a vehicle for doing so.[292] A little over a decade after *Sipriano*,[293] the Texas Supreme Court in effect expanded its embrace of capture by holding that landowners have a property right in water they intend to capture but have been purportedly restricted from doing so by government regulation.[294] And in 2015, the court let stand a November 2013 lower court decision affirming that permit decisions restricting the amount of groundwater farmers could withdraw amounted to a regulatory taking of two orchards.[295] Thus, if the Texas Supreme Court were to overrule or even introduce real exceptions to the common law rule of capture, it would need to disavow a long line of cases, including quite recent ones.

D. PATH DEPENDENCE

The responses of all three states to various externalities also highlight the importance of the legal institutions in place before the technological or other change that intensifies resource use. These institutions are sticky; from a resource-based and political perspective, modifying laws and legal systems is incredibly difficult, and thus institutions persist even as politics and preferences change. Within the Demsetz story, this means that although the increased externalities associated with greater resource use might make the transaction costs of property rights definition more worthwhile, these transaction costs might still be prohibitively high in the case of long-entrenched institutions. This path dependence appears to strongly affect whether there is a move toward the internalization of the increased externalities from intensified resource use. In some cases, path dependence allows for easier internalization of harms, with pre-existing, relatively stringent laws or precedent providing, in a way, an easy excuse to ratchet up regulation despite political opposition from an organized industry. In other cases, it fosters reliance on a tradition of relatively lax laws that prove too difficult to change despite large externalities—even those that generate a great deal of public concern.

In the case of neighborhood quality, the fact that the Pennsylvania Constitution contained the Environmental Rights Amendment—an amendment that, when adopted, had nothing to do with fracking technology that would develop decades later and that does not seem to have been even oriented to conventional oil and gas extraction—provided a basis for a plurality of justices to strike down an industry-friendly law.[296]

292. *See* Bray, *supra* note 240, at 1298–1305 (discussing the Texas Supreme Court's 1904 decision in *Houston & Texas Central Railroad Co. v. East* and its subsequent re-affirmance of the doctrine in 1955, 1978, and 1999 despite the doctrine's modification or abandonment in others States).

293. *See Siprano v. Great Spring Waters of America*, 1 S.W.3d 75 (Tex. 1999).

294. *Edwards Aquifer Auth. v. Day*, 369 S.W.3d 814, 838–45 (Tex. 2012).

295. *Edwards Aquifer Auth. v. Bragg*, 421 S.W.3d 118, 145 (Tex. App. 2013).

296. *See supra* Subpart II.B.

Path dependence also helps explains the lack of dynamism in Texas regarding rights in groundwater: because Texas, pre-fracking, began with legal doctrine (capture) and water regulatory institutions (local groundwater districts) that are not well suited to address water supply depletion risks, a total shift in doctrine and institutions would be required for there to be comprehensive adaptation to the depletion risk posed by fracking. In prior appropriation states with a strong state water agency or other state institutions, new demands for freshwater could be resolved within the context of the existing law and institutional structure, as occurred in Colorado.[297] But in Texas, new doctrine and institutions arguably would be needed, and that requires a greater political and cultural force and greater transition costs than would modification within a current framework. It was not pre-ordained that Texas would have a groundwater legal regime that is particularly poorly-suited to addressing new demands on supply; other Western, politically conservative, extraction-industry-friendly states like Wyoming apply prior appropriation to groundwater and have state and sub-state permitting authorities.[298] But Texas has adhered to a water regime that makes it poorly-suited to address depletion risks, including those from fracking.

The water quantity and quality responses in Pennsylvania and Colorado are also largely stories of path dependence. The fact that the Susquehanna River Basin Commission—a sophisticated, somewhat ecologically-oriented institution—was in place before the rise of fracking allowed for the rapid application of passby flow requirements to prevent water depletion in Eastern Pennsylvania. And the Commission's passby requirements spurred state regulators to apply similar rules in western Pennsylvania.[299]

Colorado's path dependence in the water quantity context was slightly different. Colorado appears to not have changed its laws despite increasing demands on fracking from water because those laws were already strict.[300] There was not much to be realistically changed when it came to proposed water withdrawals from water sources that were already overdrawn and highly regulated. This forced operator innovation in the form of water reuse. Industry simply had to find a way to frack despite the fact that, in some regions, no water rights were available.[301]

Considered together, these political, legal, and institutional factors show that the Demsetz theory is often complicated by forces that dampen or strengthen the push to more clearly define property rights for an activity with increasingly large externalities.

297. *See supra* Subpart II.B.

298. *See* Underground Water Act, 1947 Wyo. Sess. Laws 112–15 (providing that groundwater rights are subject to priority of appropriation, with an exception for household).

299. *See supra* Subpart II.A.

300. *See supra* Subpart II.B.

301. *See generally* OSTROM, *supra* note 7.

CONCLUSION

This Article builds upon the many legal accounts of Demsetz by exploring whether the Demsetz thesis can fully explain the legal responses (or lack thereof) to intensified resource use. The Demsetz thesis can only account for some of what we observe in the booming fracking industry. In all three case study states explored here—states with diverse geographies, climatic conditions, and political climates—some specification of property rights did emerge. But legislative and judicial politics as well as path dependence are needed to account for the differences among Pennsylvania, Colorado, and Texas. The Texas experience, in particular, shows that intensified resource use and greater externalities may even produce new legal entitlements for an industry to continue to externalize the costs of resource use. This understanding sheds light on the debate over whether federal regulation of fracking may be justified as a supplement to state regulation,[302] and also underscores the need for further empirical study of how economic and technological innovation does—and sometimes does not—impact law.

The Demsetz theory still does much of the legwork in predicting how resource users and governments are likely to respond to increasing use of a resource and associated externalities. Even in Texas, where the state responded to water quantity and neighborhood quality externalities by seemingly enhancing the right to frack for oil and gas, legislators did meaningfully change regulations in the area of water quality. But legal responses that produce full cost-internalization of resource extraction are rare, a result that is perhaps an intuitive one given that resource extraction industries are entrenched in a number of states and an increasingly polarized political atmosphere encumbers efforts at legal reform.

302. *See, e.g.*, Wiseman, *supra* note 31 (critiquing states' uneven responses); *see also* Merrill & Schizer, *supra* note 24 (arguing for the continued primacy of state regulation of hydraulic fracturing).

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