A Fractured Society:

The Socio-Legal Environment of Fracking in the United States

By

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Abstract

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This dissertation examines the relationships between law and society when encountering disruptive, risky economic activities. In doing so, it assesses how culture, politics, civil society, and powerful industry interests influence the laws and legal instruments intended to protect or benefit citizens exposed to such activities. My case is the domestic shale-energy boom brought about by "fracking," which, over the past decade, has revolutionized the US energy economy and sparked controversy for its potentially detrimental effects on local communities and the environment. By examining sociological influences on states' fracking regulations and revealing inequalities reinforced in individual mineral-rights leasing contracts, I span time and space to analyze the social forces that shape who wins and who loses when fracking comes to an area.

The dissertation is organized around three empirical studies. In the first, I draw from theories of social movements, organizations, politics, and markets to examine how social movements, economic industries, and state institutional environments influence the decisions of states to issue new regulations governing fracking or ban it altogether. Analyzing a longitudinal dataset of 34 states at risk of fracking from 2009 to 2016, and consistent with findings from political sociology and social-movement literatures, I find that increased economic security and increased environmental movement organizational capacity in a state boost the likelihood that a state will regulate the fracking industry or even ban fracking entirely. I also find that higher potential profitability (and accordingly, potential environmental risk) for fracking in a state moderates the effects of state government ideology and resource dependence on industry. These findings support my argument that the effects of non-state actors and institutional context on the regulation of disruptive industrial activity in new markets depend, in part, on the extent of potential economic benefits and societal risks posed by the economic activity.

In the second empirical chapter, I examine the political, economic, and cultural factors influencing how *stringently* states regulate fracking. Analyzing state fracking chemical disclosure requirements from 2009 through 2016, I find that a state's expected chemical disclosure stringency is most positively influenced by how stringently its geographically

proximate peer states regulate. Interacting economic hardship with fossil-fuel industry political influence is associated with less stringent regulation. I argue for a field theory-based approach to state-level regulation, which conceives of states as both constitutive of their own regulatory fields and embedded within broader fields, taking similarly situated states into account but susceptible to industry capture during particularly difficult economic times.

Finally, in the last empirical chapter, I move from the state to the local level and investigate how social inequalities become reinforced in legal instruments. Specifically, I analyze economic disparities in a ubiquitous but understudied aspect of the fracking boom: mineral-rights lease contracts. Lease contracts represent an alternative, but no less important, way that socio-legal processes determine who stands to gain, and who stands to lose, when fracking comes to town. I analyze a unique proprietary dataset of nearly 90,000 leases in Texas's Barnett shale. I find that 1) local-community embeddedness yields expected higher payments to mineral-rights owners when compared to those who reside outside of the local community, and 2) people of color, in particular those of Hispanic/Latino ethnicity, receive significantly lower royalty terms when compared to whites, all else equal. The results hold when extended to a national-level analysis. These findings suggest that local ties can open pathways to locally sourced information and confer social capital, which can be beneficial during contract negotiations. They also support sociological theories of how social biases and categories affect economic transactions, resulting in patterned inequalities and discriminatory effects for socially disadvantaged groups. This chapter opens a new empirical domain—subsurface property rights—for socio-legal studies of contracts, and it offers new theoretical directions into how social inequalities become reinforced in legal instruments.

To Mom and Dad. As educators, your dedication to public service inspires me. As parents, your love and unwavering support humble me. I hope I make you proud.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This dissertation examines the relationships between law and society when encountering disruptive, risky economic activities. In doing so, it assesses how culture, politics, civil society, and powerful industry interests influence the laws and legal instruments meant to protect or benefit citizens exposed to such activities. My case is the domestic shale-energy (i.e., "fracking") boom, which, over the past decade, has revolutionized the US energy economy and sparked controversy for its potentially detrimental effects on local communities and the environment. By examining sociological influences on states' fracking regulations and revealing inequalities reinforced in individual mineral-rights leasing contracts, I span time and space to analyze the social forces that shape who wins and who loses when fracking comes to a given area.

I spend the remainder of this introductory chapter describing oil and gas extraction process at the heart of my empirical case: "fracking." I then begin empirical analyses in Chapter 2 at the state level by examining the challenge that states have faced in deciding whether to allow fracking at all and, if so, when to implement new regulations governing this disruptive economic innovation. Specifically, I ask the following questions: when innovative but controversial economic activities simultaneously promise great economic benefits and pose significant social and environmental risks, how do social movements, economic industries, and state institutional environments influence the decision of states to regulate? How can we adjudicate between effects of these different influences across states and over time? Conducting comparative analyses on a longitudinal dataset of 34 states at risk of fracking from 2009 to 2016, I find that environmental movement organizational capacity, material-resource influence from the oil and gas sector, and government liberalism are significant predictors of states' decisions to intervene and regulate fracking. However, these effects are moderated by the extent of potential economic and environmental disruption posed by fracking. My findings support my argument that the effects of non-state actors and institutional context on how new markets are regulated depend, in part, on the extent of potential economic benefits and societal risks posed by the economic activity.

In Chapter 3, I continue to assess the state-level legal and political environments around fracking. But here, I go further and examine not how industry and civil society mobilize to affect *whether* states ban or regulate fracking, but rather the political, economic, cultural, and institutional pressures affecting how *stringently* states regulate this disruptive activity. In other words, why do states facing the same challenge—an industrial innovation that could bring economic windfalls but also grave harm to both humans and the environment—differ in how *stringently* they regulate such a challenge? Drawing from economic, political, and organizational sociology, as well as the sociology of law and sociological field theory, I test hypotheses regarding how social, political, and economic conditions affect regulatory stringency of innovative but risky economic activities. By examining the contents of laws in order to assess regulatory stringency, my approach extends conventional accounts of policy adoption. I analyze an original, longitudinal dataset of state fracking chemical disclosure requirements from 2009 through 2016. I find that a state's expected chemical disclosure stringency is most positively influenced by how stringently its geographically proximate peer states regulate. However, interacting economic hardship with fossil-fuel industry political influence is associated with less stringent regulation. I argue for a field theory-based approach to state-level regulation, which conceives of states as both constitutive of their own regulatory fields and embedded within broader fields, taking similarly situated states into account but susceptible to industry capture during particularly difficult economic times.

Finally, in Chapter 4, I move from analyzing the state regulatory environment around fracking to a socio-legal process that directly affects private individuals and communities across the country: oil and gas lease contracting. Compared to top-down regulation emanating from the state, as a legal instrument privately negotiated between oil and gas companies and private mineral-rights owners, the lease contract represents an alternative, but no less important, way that socio-legal processes affect who stands to gain, and who stands to lose, when fracking comes to town. And yet, despite hundreds of thousands of lease negotiations that have occurred during the fracking boom, sociologists lack any wide-scale, empirical studies of this process. Specifically, in this chapter, I ask: How do social inequalities become reinforced in legal instruments? Anecdotal evidence suggests that individual mineral-rights holders with relatively few social and economic resources receive unfavorable terms compared to others in the area. But it remains to be seen whether these hypotheses hold when tested across a broader area and controlling for more purely economic drivers of lease outcomes. Analyzing a dataset of almost 90,000 mineral-rights leases in Texas's Barnett shale play entered into between 2006 to 2010, I examine how local-community ties and the race/ethnicity of lease-holders affect bargaining outcomes (production royalty rates), net of the purely economic and geological forces commonly assumed to drive these contract outcomes. I find that those who live nearby or directly over the mineral estate being leased receive better deals than those who reside farther away, suggesting that one's embeddedness in the local community confers economic benefits in lease outcomes. I also find that people of color, specifically people of Hispanic/Latino ethnicity, receive less favorable payment terms compared to their white counterparts, all else equal. What is more, although data limitations prevent me from controlling for the myriad differences in geology, resources, and land-use policies for drilling areas around the entire country, a national-level analysis of nearly 500,000 leases across the United States suggests that these racial disparities in lease outcomes are occurring in other areas where fracking is taking place.

1.2 Case background

What is meant when we hear the term "fracking?" Technically, fracking (or "fracing") only refers to fracturing, a well-stimulation technique of blasting rock to stimulate the flow of fossil fuels toward a wellbore, which is the drilled hole that forms a well. Because of its adoption by anti-fracking activists and its inaccuracy as an all-encompassing term for distinct well-stimulation and drilling practices, the term 'fracking' carries a negative connotation within the energy industry. In this dissertation, however, I use the term "fracking" to reflect its meaning as understood in popular discourse. That is, I define fracking as multi-stage, high-volume "slickwater" hydraulic fracturing, combined with horizontal drilling, of "unconventional" source rock, specifically shale rock, in order to extract natural gas ("shale gas") or crude oil ("tight oil").[1] Beginning in the first decade of the 21st century, the combination of fracking stimulation innovations and horizontal drilling into one large-scale process transformed the US energy industry.

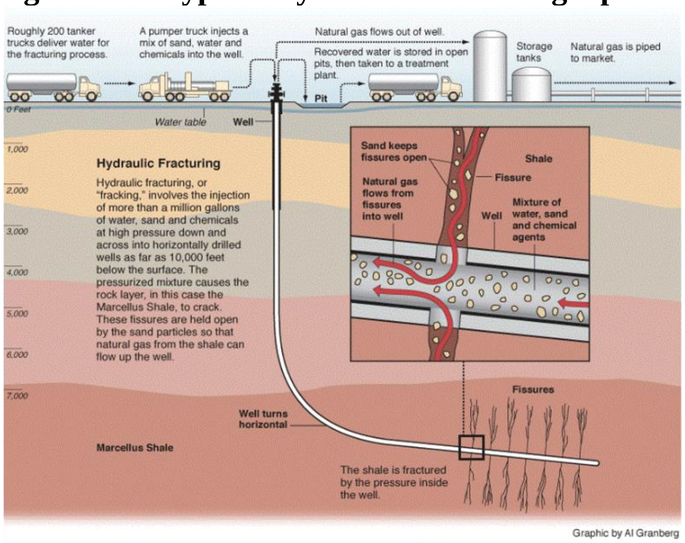
I limit my definition of fracking to stimulation from the most commonly produced

[1] State laws define fracking in different ways, but Illinois's definition is a representative example: "'High volume horizontal hydraulic fracturing operations' means all stages of a stimulation treatment of a horizontal well as defined by this Act by the pressurized application of more than 80,000 gallons per stage or more than 300,000 gallons total of hydraulic fracturing fluid and proppant to initiate or propagate fractures in a geologic formation to enhance extraction or production of oil or gas. 225 Ill. Comp. Stat. Ann. § 732/1-5 (Lexis 2014)."

"unconventional" source rock: shale. Shale is called unconventional source rock because of its relatively high porosity and low permeability compared to conventional fossil fuel sources, such as sandstone. Shale can serve as a reservoir for fossil fuels like natural gas and crude oil because of its high prevalence of open spaces within the formation (high porosity). However, shale is also resistant to fluids passing through it without applying extreme pressure (low permeability). This is why many refer to low-permeability rock as "tight" rock. Thus, "shale gas" is natural gas trapped within low-permeability, unconventional shale rock, while "tight oil" is crude oil produced tight formations, primarily shale.[2]

Figure 1.1 offers a graphical depiction of a typical hydraulic fracturing operation. Hydraulic fracturing involves the blasting of a fracking fluid—a large volume of water combined with a proppant and chemicals—deep underground to fracture shale and other tight rock formations.[3] "Slickwater" refers to the chemicals that reduce friction, corrosion, and bacterial growth, while the proppant (usually sand) props open the tiny fractures created by the high-pressure blasting so that fuels can flow to the underground wellbore for extraction. Horizontal drilling refers to the directional drilling of one or more horizontal wellbores (or "laterals") after reaching a certain vertical depth. Laterals may stretch thousands of feet. Horizontal drilling increases a well's productivity by maximizing the surface area of the wellbore that comes into contact with the most oil- or gas-rich part of the reservoir. Multi-stage fracturing—multiple fracturing stimulations along a horizontal wellbore—allows well operators to further increase surface-area contact with the producing reservoir.

Figure 1.1: Typical Hydraulic Fracturing Operation



Source: ProPublica, "What is Hydraulic Fracturing?" (http://www.propublica.org/special/hydraulic-fracturing-national)

Although the energy industry was aware of large oil and gas deposits trapped within shale

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[2] To avoid confusion with other kinds of oil trapped within shale and not extracted due to technological limitations (e.g., "oil shale"), I follow industry convention in using the term "tight oil."

[3] The volume of water used by a hydraulically fractured horizontal well varies by location, type of fuel produced, and length and number of horizontal laterals. The United States Geological Service (USGS) estimates that, in 2014, median annual water volume for hydraulic fracturing in horizontal wells was over 4 million gallons and 5.1 million gallons per oil and gas well, respectively (Gallegos et al. 2015). For comparison, Olympic-sized swimming pools hold about 660,000 gallons of water.

formations for decades, the shale boom did not begin until the early 2000s. First came years of experimentation by private energy firms, particularly Mitchell Energy in Texas during the 1980s and 1990s, and substantial research and development support from the U.S. government (Wang and Krupnick 2013). Only after combining these various production techniques and resources were producers able to tap unconventional formations at a commercially viable scale (for histories, see Wang and Krupnick 2013; Gold 2014).

Successful hydraulic fracturing combined with horizontal drilling first occurred in Texas's gas-rich Barnett shale formation during the early 2000s. As innovations spread from the Barnett to other areas, national shale-gas production began growing rapidly starting around 2006 (US EIA 2011; 2014a: MT-23; Wang and Krupnick 2013). Nationwide, from 2007 to 2013, shale gas gross withdrawals increased by 498%, from 1.99 trillion cubic feet (Tcf) to 11.9 (Tcf.). Over the same period, shale gas wells went from accounting for 8.1% of total U.S. natural-gas gross withdrawals to 39.7%, which made them the largest source of natural-gas production in the country (US EIA 2015a). Crude oil production from "tight" rock sources also increased dramatically. In October 2013, driven by fracking for tight oil, monthly US crude oil production exceeded net crude imports for the first time since 1995 (US EIA 2013a:1,4). Indeed, from 2000 to 2015, the number of hydraulically fractured wells rose from approximately 23,000 to 300,000, while crude oil produced from those wells grew from about 102,000 barrels per day (b/d) to 4.3 million b/d (US EIA 2016a). In fact, by 2015, fracking accounted for approximately half of U.S. total oil output (US EIA 2016a). And from a global standpoint, the US overtook Russia in 2009 as the world's largest natural-gas producer and Saudi Arabia in 2013 as the largest oil producer (US EIA 2015b).[4]

Importantly, fracking has not been limited to states with established fossil-fuel industries; it has also brought large-scale oil and gas production to new areas. Figures 1.2 and 1.3 depict shale-gas and tight-oil production, respectively, from 2000 through the end of 2016 by major shale formation and the primary states where each formation is found. Production of shale gas and tight oil began to explode around 2007 and 2009, respectively. For shale gas, Texas's Barnett shale was the initial boom area. The Marcellus shale, with its most productive areas lying beneath Pennsylvania and West Virginia but also located under portions of New York, Ohio, Maryland, Virginia, and Kentucky, is the leading shale gas area today and receives the most media attention (e.g., Urbina 2011). Other formations, such as the Haynesville (Texas, Louisiana) and Fayetteville (Arkansas), have also undergone a fracking boom during this period. Regarding tight oil (Fig. 1.3), the highest-producing formations include the Bakken in North Dakota and Montana, the Eagle Ford in Texas, and more recently, the Permian Basin in western Texas and southeast New Mexico.

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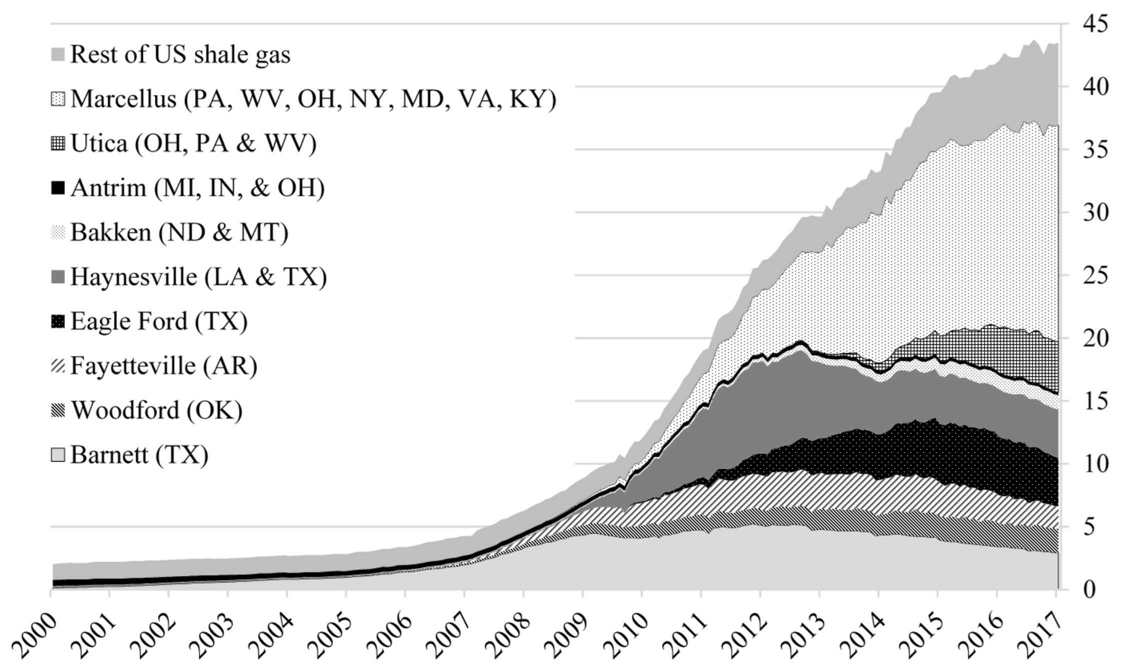
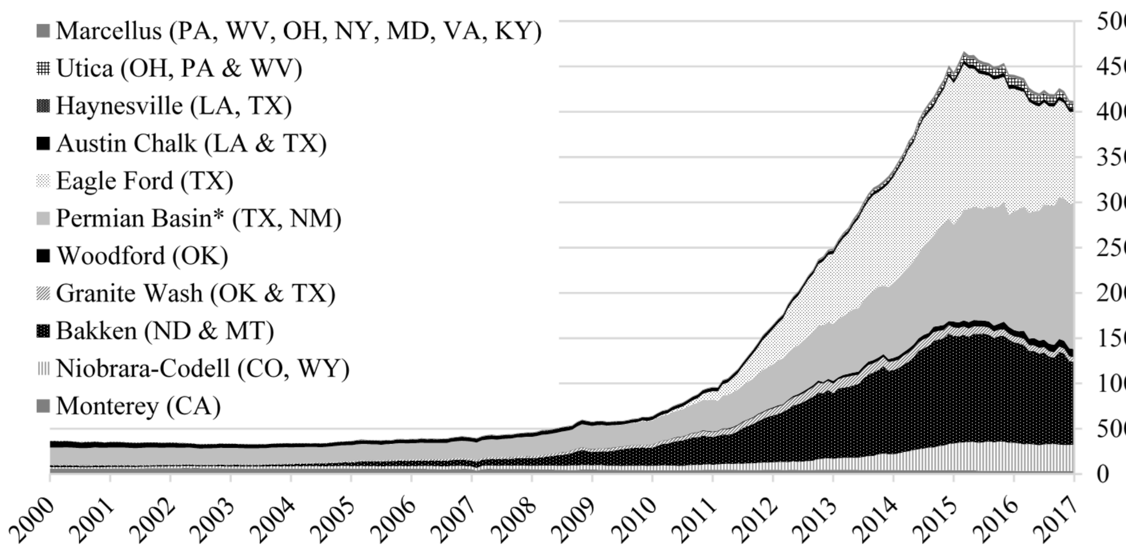
[4] The massive increases in fracking-driven supply also contributed to sharp declines in US domestic natural-gas and oil prices. Most notably, the benchmark West Texas Intermediate (WTI) spot price for crude oil fell from around $100/barrel in August 2014 to between $30 and $60/barrel throughout 2015 and 2016.

Figure 1.2: US Dry Shale Gas Production by Shale Play (in billion cubic ft. per day)



Source: US EIA (2017a). Data through Dec. 31, 2016. State abbreviations indicate primary state(s).

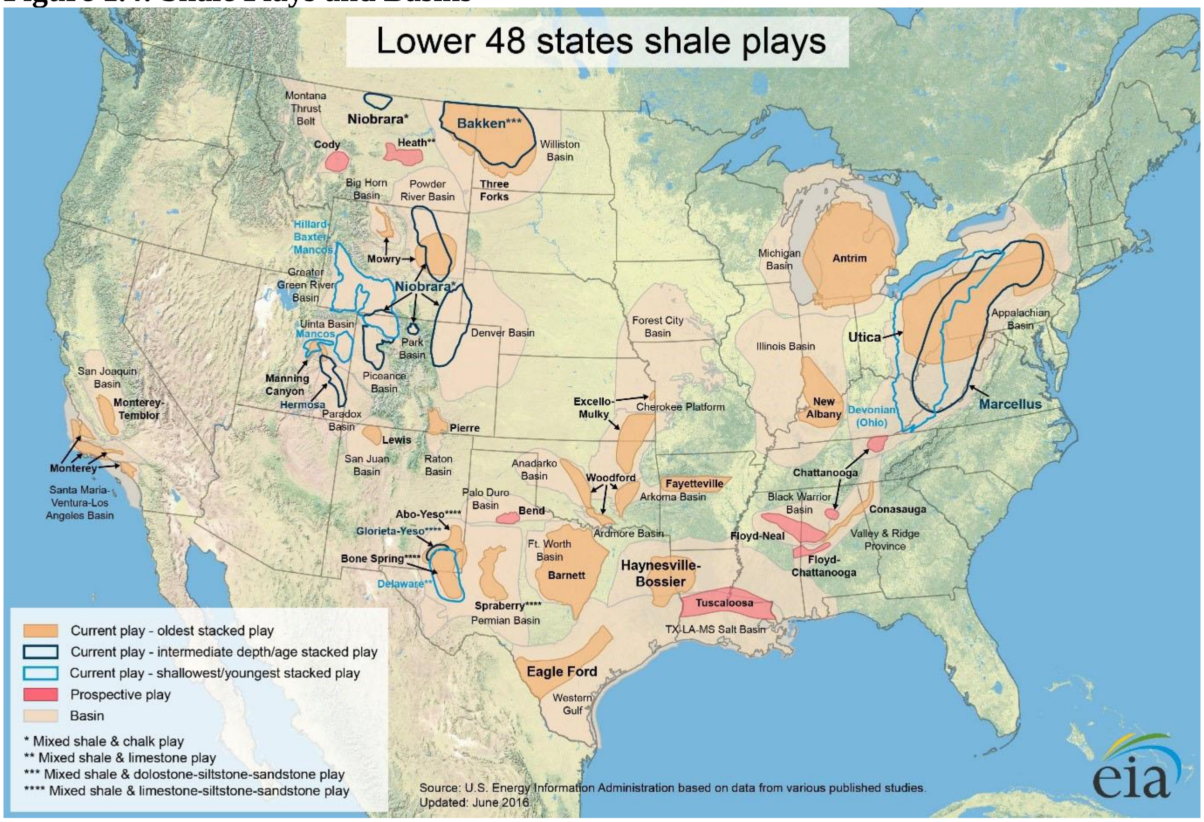
Figure 1.3: US Tight Oil Production by Shale Play (in millions of barrels of oil per day)



Source: US EIA (2017b). Data through Dec. 31, 2016. State abbreviations indicate primary state(s). Permian Basin includes Wolfcamp, Spraberry, Bone Spring, Yeso & Glorieta, and Delaware formations.

Showing the geographic reach of shale in the US, Figure 1.4 maps shale plays and basins across the contiguous 48 states. Shale plays are located within basins, which are large geologic depressions in the surface of the earth. Although the basins identified in the map contain mostly shale, basins can contain other oil and natural gas sources besides shale rock. The EIA defines a shale play as “a set of known or postulated oil and gas accumulations sharing similar geologic, geographic, and temporal properties, such as source rock, migration pathway, timing, trapping mechanism, and hydrocarbon type (US EIA 2014a:IF-14).” In other words, shale plays are shale formations within basins that are either productive today or have been identified as of potential interest to the oil and gas industry. According to the EIA (US EIA 2016b), 34 states are located over some portion of a basin, while 28 sit above a shale play.

Figure 1.4: Shale Plays and Basins



Across the country, fracking has brought many community disruptions. It has generated heated public debate regarding its economic impacts, environmental and health risks, and strain on community resources and infrastructure (e.g., Fox 2010; Urbina 2011-2012). Empirical studies have also documented the local impacts of fracking (e.g., Brasier et al. 2011; Davis 2012; Weber 2012; Jacquet 2014; Malin 2014; Crowe et al. 2015; Hefley and Wang 2015; Vasi et al. 2015; Dokshin 2016; Feyrer et al. 2017). In the most active shale areas, production companies first rush to purchase mineral-rights leases from individuals in exchange for potentially lucrative bonus and royalty payments. An influx of outsiders then arrives to work on drilling sites, trucks fill the roads, and sounds of construction fill the air. Economically, unemployment figures fall, rents and home prices change, and once-sleepy motels and restaurants bustle. Politically, anti-fracking groups mobilize, severance tax revenues soar, legislators debate energy issues, and regulatory agencies scramble to update or issue new fossil-fuel, land-use, and environmental rules. In the terms of sociological field theory (Fligstein and McAdam 2012), new players arrive, local players sitting on valuable land can suddenly increase their standing in the field or prevent an energy company from realizing theirs, rules (both formal laws and informal norms) are reinterpreted, new political issues are contested, and the relative influence of other players (e.g., regulatory agencies, lobbyists, social movement organizations) can shift dramatically.

CHAPTER 2

RAISING THE STAKES: THE EFFECTS OF INDUSTRY, THE ENVIRONMENTAL MOVEMENT, AND STATES' INSTITUTIONAL CONTEXTS ON THE DECISION TO REGULATE FRACKING

2.1 Introduction

What role do social movements, economic industries, and existing state institutions play in the regulation of innovative but controversial economic activities that simultaneously promise great economic benefits and pose significant social and environmental risks? How can we adjudicate between the effects of these different influences across states and over time? In this chapter, I analyze a longitudinal panel dataset to explain variation within and across US states in the regulation of hydraulic fracturing ("fracking"), which has transformed the energy economy and sparked significant controversy over the past decade. As an industrial innovation that brings enormous economic change while carrying dangerous environmental risks, fracking has prompted both the oil and gas industry and environmental social-movement organizations (SMOs) to engage in collective action as they work to organize the new social space centered around it. Both of these groups also must operate within their particular institutional contexts. One of the most important targets of their efforts has been state governments, which have primary responsibility for regulating fracking. As the fracking boom quickly took off and spread across the country, states scrambled to develop regulatory regimes around it. Many states subject to the possibility of fracking have never dealt with oil and gas production, and even states that have had drilling in the past have nevertheless have encountered novel regulatory issues that apply specifically to fracking. Business interests and environmental SMOs have thus mobilized across the country to engage in the contentious politics of how to govern fracking.

The impacts and disruptions of fracking

As discussed in Chapter 1, fracking has brought large-scale oil and gas production (and the potential for production) to new areas. Production of shale gas and tight oil via fracking took off around 2007 and 2009, respectively. I refer back to Figure 1.4, which maps the various shale basins and plays across the contiguous 48 states. Shale plays are located within basins, which are large geologic depressions in the surface of the earth. Although the shale basins in Figure 1.4 contain mostly shale, basins can contain other oil and natural gas sources besides shale rock. As for shale plays, they are shale formations within basins that are either productive today or have been identified as of particular interest to the oil and gas industry. Based on data from the EIA's 2016 shale assessment (US EIA 2016b), 34 states sit over some portion of a basin, while 28 states are located over a shale play. The Barnett shale play in Texas was the early mover in shale-gas production. The Marcellus and Utica shale plays, around Pennsylvania, eastern Ohio, upstate New York, and West Virginia are the leading shale gas areas today. For oil, the highest-producing formations include the Eagle Ford in Texas, the Bakken in North Dakota and Montana, and plays in the Permian Basin in western Texas and southeast New Mexico.

Beyond bringing enormous economic changes, though, fracking brings many state-level and community disruptions. It has sparked controversy and media scrutiny over questions of economic and environmental impacts, health risks, and strain on community resources and infrastructure (Urbina 2011-2012; Vasi et al. 2015). Empirical studies in sociology and economics have documented individual- and local-level economic, psychological, and political impacts of fracking. In the busiest areas, the influx of outsiders and spiked economic production have sparked modern-day 'boomtown' dynamics (England and Albrecht 1984): newly arrived residents begin working in the area, open land becomes dotted with well pads, unemployment drops, rents and home prices rise, motels and restaurants bustle, and perceptions of risk and development change, anti-fracking groups mobilize, severance tax revenues soar, legislators debate energy issues, and regulatory agencies scramble to update or issue new rules (*e.g.*, Brasier et al. 2011; Davis 2012; Muehlenbachs et al. 2015; Vasi et al. 2015; Dokshin 2016; Feyrer et al.

2017; *see generally* Jacquet 2014; Neville et al., 2017).

Regulation of fracking

As the fracking boom has spread across the US, states have been responsible for governing it. Aside from a few specific issues, mostly related to water and air quality or drilling practices on federal lands, the regulation of fracking has been left to the states. These states vary greatly in their regulation of fracking-related production activities. Because many states overlying shale formations already had oil and gas production from conventional sources occurring before the fracking boom, most of them had general oil and gas regulations and statutes in place prior to the 2000s. However, all states face at least the *possibility* of regulatory change because fracking brings major economic and environmental disruption and involves a novel extraction process. The issue of chemical disclosure regulation (described in Section 3.1 below) stands out as one of the few types of regulations that all states facing the potential for fracking have addressed, regardless of whether they had experience with fossil-fuel production prior to fracking.

Based on my review of state laws, 29 states implemented new or revised existing statutes or regulations specifically to address fracking chemical disclosure between 2009 and 2016.[5] In 2008, New York became the first state to take new legal action with respect to fracking, effectively placing a moratorium on fracking when Gov. David Paterson ordered the state's Department of Environmental Conservation (DEC) to review safety and environmental issues associated with fracking before the state would issue drilling permits.[6] By the end of 2016, however, 29 states had some form of disclosure requirement, with an additional state having a moratorium on drilling (Maryland) and two other states banning fracking altogether (New York; Vermont). Another two placed a moratorium on fracking during at least one other year of the study period.[7] Figure 2.1 depicts the states that had adopted disclosure regulations, fracking moratoria, and bans by the end of the first and last year of my study period. It illustrates the emergence of fracking regulations over this period. Yet to be understood at a national level are the relative influences of various institutional factors, industry mobilization, and social movements on the decisions of states to intervene and set market rules by regulating fracking.

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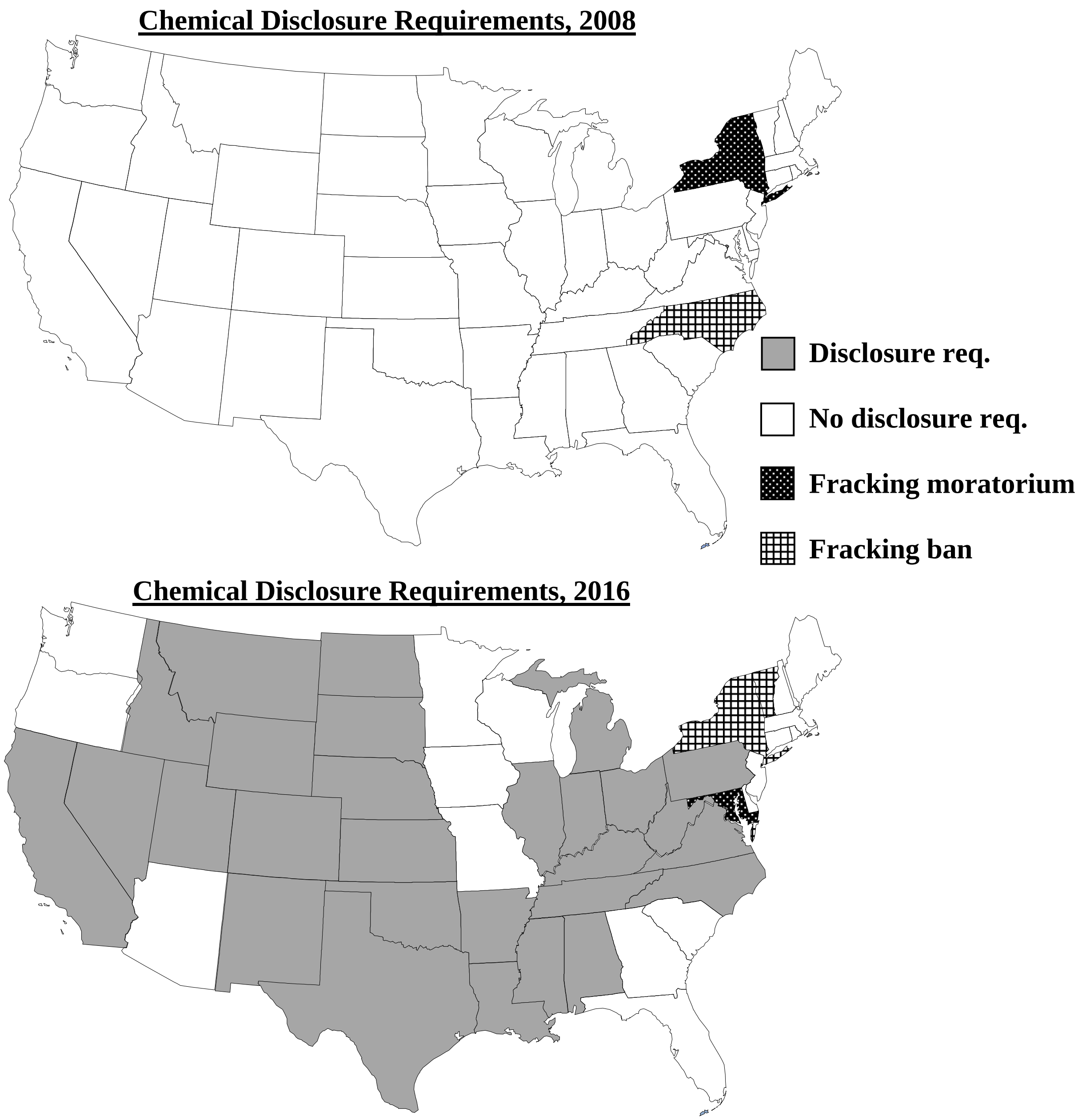
[5] Alabama, Alaska, Arkansas, California, Colorado, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Montana, Nebraska, Nevada, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, and Wyoming.

[6] The moratorium on fracking in New York continued until New York's DEC officially banned fracking in June 2015 (NY DEC 2015).

[7] New Jersey and North Carolina. Vermont and North Carolina are not included in the sample I analyze below because they do not contain any portion of a shale basin. Their regulatory decisions, from this shale-focused perspective, were therefore symbolic (Meyer and Rowan 1977)

Figure 2.1: Hydraulic Fracturing Chemical Disclosure Requirements, 2008 and 2016



Note: Chemical disclosure requirements represented here are those specifically applicable to hydraulic fracturing. Data represent status of regulations and laws as of December 31 of the applicable year.

2.2 Theory development

Effects of industry and movements on state action

To motivate my analysis, I draw from scholarship in economic sociology, organizational theory, social-movements, and political sociology. Sociologists and political economists as far back as Weber (1978) have theorized the relationship between the economy and the state, two bedrock institutions of modern capitalist society. Polányi (1944) showed how even the most "free" market economies depend on government to supply and regulate the fictitious commodities of land, labor, and money essential to the functioning of markets. Polányi also showed how the tension between two competing movements—the drive for laissez-faire and market expansion on one hand and the movement for socio-environmental protection from market forces on the other—influence the regulation of economic activity in market societies. State governments navigate these competing interests in their regulation of the economy.

More recently, sociologists have empirically tested and built upon these theories, showing how the state, politics, and economic institutions mutually constitute one another (*e.g.*, Dobbin 1994; Fligstein 2001; Schneiberg and Bartley 2008). However, as Edelman and Stryker (2005:528) point out, "law is [still] not often a sustained object of inquiry in its own right," particularly for economic sociologists. Scholarship in political sociology and policy studies, of course, has examined conditions affecting the passage of legislation, but they usually focus on either social welfare policies (*see* Burstein and Linton 2002) or economic development policies (*e.g.*, Jenkins, Leicht, and Wendt 2006) over relatively long-run historical periods (*see also* Dobbin and Dowd 2000; Schneiberg and Bartley 2001). Mostly understudied are contemporary, twenty-first century cases of regulatory action by administrative agencies (rather than legislation) tasked with governing economic innovations that simultaneously promise economic windfalls but also put citizens and communities at risk. Fracking is such a case.

The unlocking of vast economic potential in new areas and the risks of harm imposed by fracking—all situated within a federalist system of governance and amidst the backdrop of climate change and the sudden prospect of vast, untapped domestic fossil-fuel resources—has given rise to its own sub-national fracking "policy domain" (Laumann and Knoke 1987; Fligstein 2001). Laumann and Knoke (1987:10-11) define a policy domain as composed of a set of actors concerned with formulating, advocating, and selecting courses of action (i.e., policy options) about a substantive area of mutual relevance and whose disclosed intentions and actions are taken into account in the actions of other domain participants. This is consistent with a field-theory based view of policymaking, as groups and coalitions struggle for influence and the ability to institutionalize their views into laws and regulations (Schneiberg and Soule 2005; Fligstein and McAdam 2012). The growing literature bridging organizational theory, social movements, and political sociology offers some guidance regarding the conditions under which different constituencies will affect fracking regulation.

First, access to and control over resources play a critical role in all phases of social-movement activity, including their ability to effect political change (McCarthy and Zald 1977). The most obvious type of material resource, deployed by movements and firms alike, to influence government actors is money. By donating to political campaigns, committees, and political action groups, firms and SMOs seek to further their interests in getting candidates elected, setting agendas, and influencing laws. Contemporary research on electoral politics is mixed on whether political contributions directly influence policy (Burstein and Linton 2002; Johnson et al. 2010; Grossman 2012), but the consensus remains that firms and movements alike use material resources to influence political and regulatory outcomes (Fligstein 2001; Walker and Rea 2014). The economic disruption brought about by fracking has created an opportunity for stakeholders, particularly the oil and gas industry and environmental activists, to influence regulation by advocating for decreased or increased regulatory stringency, respectively (see Rinfret et al. 2014).[8] A primary avenue for exerting such influence is through supplying material resources to state political actors, principally through monetary political contributions.

H1a: The more material resources aimed at government actors by industry, the less likely the state will intervene to regulate economically and environmentally disruptive activities.

H1b: The more material resources aimed at government actors by the environmental movement, the more likely the state will intervene to regulate economically and environmentally disruptive activities.

Independent of material-resource donations, the organizational capacity of social movements should also influence state economic regulation. Organizing is crucial to movement success, and the infrastructure to support a wide range and large number of movement organizations is a key component of a movement's ability to organize politically (McAdam 1982; Amenta et al. 2010; Johnson et al. 2010).

H2: The more developed the environmental movement organizational capacity of a state, the more likely it will enact regulation addressing environmentally risky economic activities.

In addition, organizational sociologists since at least Pfeffer and Salancik's (1978) seminal work have theorized how resource dependencies structure inter-firm relations, whereby firms that are dependent on others for critical resources are subject to their influence. A similar logic applies to the industry-state relationship: the more dependent the state on an industry, the more likely that that industry can exert power over the state and press its political agenda on state government actors.

H3: As the dependency of a state on an industry increases, the less likely the state will intervene and regulate the industry's economic activity.

Political and economic context

Those studying political mobilization, whether by social movements or from corporate actors, must go beyond examining organizational features and self-interests of movement actors themselves and consider how the political, cultural, and economic contexts of their environments affect the ability of these groups to further their political interests. Social-movement scholars have developed and refined these ideas through their emphasis on how a movement's surrounding political opportunity structure affects movement formation, participation, and strategies (McAdam, Tarrow, and Tilly 2001; Meyer 2004). More recently, scholarship on firms, markets, and regulation has increasingly incorporated from the social-movement literature concepts of political opportunity structure to help explain the political mobilization of firms and contestation between movements and industry actors over rules regulating markets (King 2008; Schneiberg and Bartley 2008; Soule 2009; King and Pearce 2010; Walker and Rea 2014; Jung 2017).

[8] State policymakers and regulators are not predestined to slavishly follow corporate wishes, even when setting environmental policies, because they consider their own interests in getting re-elected/re-appointed, the broader interests of their states with respect to other jurisdictions with which they compete, and the complexities of how issues are framed in terms of economic development (Rabe and Mundo 2007).

Both lines of scholarship suggest that the political culture of the state can independently affect the extent to which the rules governing markets favor social protectionist advocates or business interests. One such factor that has been shown by numerous studies of social movements to influence movements' political or legal efficacy is the partisan political climate of the surrounding political environment (Amenta et al. 2010:99). Officials define, interpret, and carry out economic policies not simply according to their strategic interests in being re-elected or appointed but also in accordance with their political identity and ideology (Dobbin 1994; Fligstein 1996). Whether coming from SMOs or industry, organizations seeking to instantiate their interests in rules governing market activities stand a better chance of success when they have elite allies in the political structure who will be receptive to their ideas or claims (Soule and Olzak 2004). In the American context, and relative to conservatives, liberals generally prefer more government intervention in markets and more stringent regulation of environmentally risky business activities. Thus, states with more liberal governments should be more receptive to regulation of environmentally risky activity by implementing rules protective of social welfare than of furthering business interests.

Hypothesis 4: The more liberal the governmental regime, the more likely the state will implement regulation to protect social welfare.

Amplified effects as stakes are raised

Finally, an under-examined aspect of the relationship of business- and movement-based influences on legal outcomes is the extent to which the economic and social stakes involved moderate predicted effects. Drawing from theories of political mediation in social-movements scholarship on how political context can mediate the relationship between movement-centered features (e.g., resources, size) and movement outcomes (e.g., Amenta, Caren, and Olasky 2005; Agnone 2007; Amenta et al. 2010; Johnson et al. 2010), I predict that, in cases where the market activity in question poses both significant economic promise but also health and environmental risk, higher stakes moderate predicted effects. This is in line with a field-theory conception of market activity and policy domains, which suggests that economically disruptive activities or events will increase the likelihood that a state will intervene and impose order through policies and regulation (Fligstein and McAdam 2011:19). Thus, I posit that mobilizing groups from industry and civil-society will assert their interests—in favor of business for the former, in favor of social and environmental protection for the latter—more strongly on economic regulations as the level of disruption, in the form of potential economic rewards and concomitant societal risks, increases. In plain terms, groups have more incentives to mobilize and affect the "rules of the game" governing markets as the consequences of economic activities become more meaningful to their own interests. Thus, for each hypothesized relationship for main effects, I expect a moderation effect when taking into account the economic potential of "frack-able" resources in a state.

Hypothesis 5: As the economic and environmental stakes of a market activity rise in an area, predicted industry and movement effects on regulatory outcomes will also increase.

2.3 Data and Methods

I examine the extent to which the oil and gas industry, the environmental movement, and various state-level institutional factors affect a state's decision to refrain from regulating fracking, regulating it, or ban it completely or issue a moratorium on drilling. To test my hypotheses, I estimate between-within, 'hybrid' fixed-effects ordered logistic regression models (Allison 2009) on a longitudinal panel dataset of the 34 US states with the potential for fracking from 2009 to 2016. Table 2.1 presents constructs and measures, which I describe below.

Table 2.1: Constructs and Measures

Construct	Measure
Dependent Variables	
Fracking regulation	Ordinal scale of fracking-specific chemical disclosure regulation 0=no reg, 1=regulation, 2=ban/moratorium
Indep. Variables	
govt liberalism (H1)	State govt. ideology (higher score = more liberal)
env mvmnt contrib (H2)	Logged dollars contributed by pro-environmental donors to state political campaigns and committees
oil-gas dependence	Logged dollars contributed by oil & gas extraction sector to state political campaigns and committees
oil-gas dependence	% of state GSP contributed by oil-gas extraction sector
env mvmnt org capacity	Registered environmental orgs per 100k residents
Controls	
economic health	Real GSP per capita (chained 2009 dollars)
fracking potential	% of state area overlying shale play

Dependent variable

The dependent variable is an ordinal measure for the presence of fracking-specific regulation. Specifically, I use chemical disclosure requirements as the outcome in the models. It is an ordinal measure, where 0 represents no fracking regulation, 1 indicates that a requirement has been put into effect, and 2 indicates that the state issued an outright ban or moratorium on fracking. Disclosure rules require well operators to disclose the potentially toxic chemical mixtures they add to the water that fractures shale rock. To collect each state's chemical disclosure regulations, I searched each state's legal and regulatory archives on legal databases (Lexis and Westlaw) and state regulatory agency websites for the state regulations and laws in effect on December 31st of the focal year.

I selected chemical disclosure regulations because they are explicitly targeted at fracking and thus exhibit a high degree of facial validity for capturing the concept of regulating fracking. Most oil and gas laws and regulations (e.g., well-pad spacing regulations, mineral-rights leasing rules, permitting requirements) have been "on the books" for decades and, even if amended recently, may or may not be designed specifically for "fracking" as we know it today. They thus present challenges when collecting and coding state regulations pertaining to oil and gas development.

Although I use chemical disclosure rules as a proxy for the issuance of fracking-specific regulation generally, such rules yield added opportunities to study how firms, social movements, and state political-cultural environments structure the rules that guide action in a newly formed economic setting. First, a review of media and scholarly accounts of fracking regulation strongly suggests that chemical disclosure is the most contested and discussed regulatory issue surrounding fracking (e.g., Wiseman 2011; Murrill and Vann 2012; Fisk 2013; McFeeley 2014; Konschnick and Dayalu 2016). Second, disclosure regulation helpfully illustrates the alternative ways in which contemporary economic regulations are conceived, contested, and carried out. On one hand, chemical disclosure regulations in the fracking context are a pseudo-private form of 'regulation by information' (Schneiberg and Bartley 2008:43; Short and Toffel 2010), wherein the state takes an indirect role by delegating some oversight and/or sanctioning to quasi-state entities, the public, or industry itself. One can alternatively conceive of disclosure requirements as regulations designed to reduce information asymmetries between industry, the public, and the state, thereby reducing the public's information-seeking costs that intellectual property laws and lack of technical expertise impose (Wiseman 2011). In other words, the public has a right to know whether energy firms are engaging in activities potentially harmful to health and the environment (Stephan 2002). A chemical disclosure requirement is therefore a kind of a social-welfare policy in that it aims to protect the public from the risk of groundwater contamination. Of course, if one focuses on the regulations' trade-secret protections that, depending on how the rules are crafted, can (and often do) allow producers to decline to reveal potentially harmful, but proprietary, chemical constituents, disclosure requirements could also provide an economic incentive to producers to drill in a state.

Independent variables

Industry and environmental movement political influence. I based my measures of the oil & gas industry and environmental movement political influence variables (Hypotheses 1a and 1b) on the rationale that material resources donated to government actors can yield influence and political power for donors. To construct the measure, I used state-level political contribution data obtained from the National Institute on Money in State Politics (NIMSP 2017). This organization collects detailed contribution records from all fifty states and compiles them into a publicly available database. It also provides detailed information on each contributor, including the industry/sector with which each contribution is affiliated. The accuracy and coverage of the data have been verified by scholars (Bender 2013).

I leveraged these data to construct a measure of the influence of the oil and gas industry and environmental movement in a given state-year. For each state-year, I recorded the total dollars contributed by the oil and gas sector and by pro-environmental donors. I adjusted the figures to chained 2009 dollars using the annual average Consumer Price Index for all urban consumers (US BLS 2016b). For any missing state-year observations, almost all of which were in non-election years, I used nearest-neighbor interpolation to fill in data. Finally, I calculated the natural log of each observation for use in the statistical models reported below.

Oil & gas dependence. The oil & gas dependence variable captures the extent to which a state is economically reliant on the industry to be regulated, a commonly used measure in state policy research. I measure it by calculating the percentage of a state's all-industries total real gross domestic product (state GDP) (chained 2009 dollars) produced the oil & gas extraction sector. This sector's classification (Industry Code=7) is based on the 2007 North American Industry Classification System (NAICS). I obtained sector-level and national state GDP data from the US Bureau of Economic Analysis's Regional Economic Accounts database (US BEA 2017).

Environmental movement organizational capacity. To measure social-movement organizational capacity, I draw from the IRS Business Master File, provided by the Urban Institute's National Center on Charitable Statistics (NCCS 2017). These data provide information on nonprofit organizations claiming tax-exempt status with the IRS. I select only organizations registered with the IRS as a 501(c) exempt organization in a given state-year and whose purpose is classified by the IRS as "Environmental Quality, Protection & Beautification" under the National Taxonomy for Exempt Entities system (NTEE-CC major group "C"). In order to collect data on as many environmental groups as possible, I use as my measure all organizations that filed a Form 990, 990-EZ, 990-PF and 990-N electronic postcard within 24 months of the given

BMF release date, as reported in NCCS Core Files and IRS Business Master Files. I capture the population density of environmental organizations at each state-year, rather than the count, by using a per-capita measure of environmental organizations per 100,000 residents (annual resident data from the US Census).

The population density of SMOs within a movement is commonly used to measure the strength of organizational capacity of a movement (Minkoff 1997), particularly in studies of the of the environmental movement (e.g., Johnson et al. 2010). Of course, reliance on this single source to estimate a state's population of environmental organizations, even if it is widely used by researchers and seen as the most comprehensive single source available, may be biased toward non-voluntarist organizations and may underestimate smaller, local environmental organizations (Andrews and Edwards 2004). However, by including even the small organizations eligible to file 990-N electronic postcards to the IRS, my measure is reasonable given my purposes here and limitations of gathering these data on 272 state-years.

Government liberalism. To measure state government ideology, I used a scale of ideology often employed by political science and policy scholars (for a list of publications, *see* Berry et al. 2013:165). Originally developed by Berry et al. (1998), the scale is a weighted average of the ideological positions of five political institutions in each state: the Democratic and Republican delegations in the state house, the Democratic and Republican delegations in the state senate, and the state Governor. Each state congressional chamber's ideology score is itself based on a combination of its members' ideal point estimations using data from Project Votesmart's National Political Awareness Test (now called the Political Courage Test) annual survey of state legislative candidates as well as each party's share of seats it controls in each chamber. The resultant state-government summary score thus represents the ideological balance of a state government in a particular year during the study period. Scores fall on a continuum, with zero representing the most conservative position and 100 the most liberal.

3.3 Controls

The lone time-invariant, level-two variable represents the degree of fracking potential in the state. I measure it by calculating the percentage of a state's total surface area that lies above a shale play. Recall that, in order to analyze only states that could potentially have fracking, the sample of states I analyze here consists of only those states located within a shale basin. Shale plays are distinct from shale basins in that plays are limited to those areas where oil and gas production is currently occurring or currently economically viable. In other words, a state can be located within a shale basin but not necessarily within a shale play. Indeed, six of the 34 states in the sample contain shale but are not considered to be overlying a shale play: Arizona, Florida, Iowa, New Jersey, South Dakota, and Wisconsin (US EIA 2016b). This fracking potential variable, as a proxy for how high the stakes are to business and environmental movement organizations, serves as not only a control in the model for main effects but also as the primary variable used to test the hypothesized moderation effects for the independent variables (Hypothesis 5).

Analytic Strategy

The unit of analysis for the longitudinal panel dataset is the state-year. I conduct analyses on the 34 US states located within a shale basin from 2009 to 2016 (n=272 state-years, 34 states, eight periods).[9] Restricting the sample to states with some portion of a shale basin allows me to analyze only those states at risk of newly drilled fracking-based wells. The outcome is measured on an ordinal scale (no regulation, regulation, ban/moratorium).

I follow Allison's (2009:23-25) "between-within" modeling approach (also called a hybrid fixed-effects approach) and estimate an ordered logistic regression model with a random intercept for each state.[10] This is especially useful in my case, as standard fixed-effects methods (e.g., conditional likelihood) are unavailable for ordinal logistic regression. Treating state-year observations as clustered within states, I include as covariates in models both the cluster-specific means of each variable and the deviation from that cluster-specific mean, thereby allowing me to obtain unbiased estimates of within-state (fixed) effects for the time-variant predictors.

Fixed-effects models, unlike their random-effects counterparts, do not impose the assumption that unobserved, time-invariant variables (i.e., the level-two error) are uncorrelated with the observed covariates. This random-effects assumption is almost always unrealistic in practice (Halaby 2004; Vaisey and Miles 2017). The primary disadvantage of conventional fixed-effects models, however, is that they do not allow one to obtain estimates for time-invariant variables, which are often important to social scientists. By employing a random-effects estimator and including cluster-means of the time-variant variables as covariates, which act as state-level controls, the between-within method yields unbiased fixed-effects estimates for time-variant (level-one) variables while also allowing me to include important time-invariant variables in the model. In its latent-response formulation, the model for main effects is expressed as:

$$y_{it}^* = \alpha + \beta_1 X_i + \beta_2(XT_{it} - \overline{XT}_i) + \beta_3 \overline{XT}_i + \zeta_i + \epsilon_{it} \qquad (1)$$
$$\zeta_i | x_{it} \sim N(0, \psi)$$
$$\epsilon_{it} | x_{it}, \zeta_j \sim N(0, \theta)$$

where y_{it}^* is the latent-response formulation for the ordinal dependent variable of regulation for each state *i* at year *t*, $\beta_1 X_i$ is the random (between-) effect of the time-invariant predictor *X*, $\beta_2(XT_{it} - \overline{XT}_i)$ is the fixed (within-) effects of the vector of time-variant predictors *XT*, and $\beta_3 \overline{XT}_i$ is the between-effect of these time-variant predictors. The conditional distribution of latent response y_{it}^* given the random effects is assumed to be multinomial. The model in (1) allows each state cluster *i* to have its own intercept and splits the total error into a cluster-level (level-two) error ζ_i and unit-level (level-one) error ϵ_{it}. ζ_i is assumed independently distributed across states *i* and independent of covariates x_{it}. The distribution of the unit-level error term ϵ_{it} is assumed to be standard logistic. The ϵ_{it} is further assumed to be independent across states *i* and years *t*. ψ is the between-cluster variance and θ is the within-cluster variance. The three-category, ordinal response y_{it} is related to the latent response y_{it}^* via the threshold model:

$$y_{it} \begin{cases} 1 & \text{if} \quad y_{it}^* \leq k_3 \\ 2 & \text{if} \quad k_1 < y_{it}^* \leq k_2 \\ 3 & \text{if} \quad k_2 < y_{it}^* \leq k_3 \end{cases}$$

I lag all time-variant predictors one year to avoid reverse causality. I report clustered robust standard errors to adjust for panel-level heteroskedasticity (Huber 1967; White 1980; Williams 2000).

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[9] Although the first observation of fracking-specific regulation occurred in 2008 with New York's moratorium on fracking, it was the only state to regulate in 2008. Because of this lack of variation in the data, I begin analysis a year later in 2009.

[10] Between-within models are related but distinct from correlated random-effects models (Schunck 2013).

2.4 Results

Descriptive statistics and pairwise correlations

I present descriptive statistics and pairwise correlations of the variables in Table 2.2 and Table 2.3, respectively. For the dependent variable, the level of fracking regulation, the frequency table shows that three states (New York since 2009, Maryland since 2011, and New Jersey in 2011 & 2012) had a ban or moratorium on fracking in effect at some point during the study. These 16 state-years represent 5.88% of the sample. The remaining state-years were split nearly evenly among those with (43.1%) and without regulations (51.1%), even though all states were at some risk of fracking, even if minimal, by virtue of being located within a shale basin.

Table 2.2: Descriptive Statistics

Variable		Mean	Std. Dev.	Min	Max
regulation (DV)	overall	0.55	0.61	0	2
	between		0.41	0	2
	within		0.45	0	2
fracking potential	overall	23.70	36.28	0	150.98
	between		36.76	0	150.98
	within		0	23.70	23.70
economic health	overall	45640.37	7934.83	31167	71056
	between		7767.73	31813.13	63495.25
	within		2045.07	33943.75	56620.75
govt liberalism	overall	39.98	27.96	3.02	89.41
	between		24.18	4.71	85.67
	within		14.56	11.46	85.92
env mvmnt political influence	overall	9.31	2.50	3.91	16.74
	between		1.39	6.32	11.66
	within		2.09	3.13	16.26
oil-gas political influence	overall	11.94	2.09	4.61	17.09
	between		1.27	9.66	15.20
	within		1.68	6.82	15.82
oil-gas dependence	overall	1.79	3.22	0	16.26
	between		3.14	0	11.98
	within		0.86	-1.81	6.91
env mvmnt org capacity	overall	7.11	4.02	2.75	25
	between		3.98	3.35	23.08
	within		0.83	2.57	9.37

n=272 (34 states, 8 years)
DV (2009-2016); all other variables 2008-2015 to account for lagged predictors reported in models

Frequency table of dependent variable

Outcome categories	Overall		Within	Between
	Freq.	Percent	Percent	
No reg.	139	51.1	52.65	
Regulation	117	43.01	58.5	
Ban/moratorium	16	5.88	66.67	
Total	272	100	55.74	34

The mean percentage of total surface area over a shale play across all states in the sample is 23.7% (SD=36.28). The state with the highest percentage of shale play is West Virginia (150.98%). This exceeds 100% for West Virginia, as well as Pennsylvania and Ohio, because these states overlie multiple shale plays stacked vertically at different depths thousands of feet below ground. Pennsylvania, for example, contains the Devonian (Ohio) shale play, which lies above the Marcellus, which itself lies above the Utica.

For the time-variant variables, I briefly highlight selected features revealed by the descriptive statistics in Table 2.2. For the economic health control, the overall mean real GSP is $45,640 per capita (2009 dollars). In 2014, North Dakota—with the surge in production and employment attributable to fracking in the oil-rich Bakken shale fields— had the highest annual GSP ($71,056 per capita) among all state-years in the dataset. The governments with the most conservative and most liberal ideologies were Arizona (2014 and 2015) and California (2011 and 2012), respectively. The mean ideology across all states in the sample was fairly conservative on the 100-point ideology scale (mn=39.98, sd=27.96). Perhaps not surprisingly, overall annual oil & gas industry political influence (mn=11.94, SD=2.09) is much higher than political influence from environmental donors (mn=9.31, 2.5). These logged figures translate to $153,276.69 and $11,047.948, respectively. Georgia (2013-2015) and Iowa (2008-2015) had no oil and gas dependence, which I measured as the percentage of a state's annual GSP attributable to the oil and gas extraction sector, while Wyoming in 2009 led all states in the sample with 16.26% of its GSP coming from this sector. Overall, the average dependence was much lower, at 1.79% (sd=3.22). Finally, for environmental movement organizational capacity, the average state had 7.11 environmental organizations per 100,000 residents (sd=4.02), with Mississippi in 2008 (x=2.75) and Montana in 2015 (x=24.99) having the minimum and maximum across the sample.

Table 2.3: Pairwise correlations

		1	2	3	4	5	6	7	8
1	regulation (DV)	1							
2	fracking potential	.2425**	1						
3	economic health	.3073**	-0.013	1					
4	govt liberalism	.0912	.1238*	.1387*	1				
5	env mvmnt political influence	-.0949	-.1032	.1065	.0567	1			
6	oil-gas political influence	.0404	.0784	.1021	.0741	.3689**	1		
7	oil-gas dependence	.1603**	.1270*	.2598**	-.1608**	-.1772**	.2029**	1	
8	env mvmnt org capacity	.1754**	.0614	.2178**	.0779	-.0724	-.1524*	.2719**	1

n=272 (34 states, 8 time spells); All independent variables lagged one year

* p<.05, **p<.01

Regression results

Table 2.4 displays the results of regressing fracking regulation on the variables described above. Coefficients are expressed as odds-ratios.[11] Model 1 displays results for the model testing all main effects with no interactions. Models 2-6 show how the results for the main effects change when including one interaction of each covariate with fracking potential, and Model 7 shows results for the full model, which includes all main affects and all interactions of the time-

[11] Because ordered logistic regression models follow the proportional odds assumption that the estimated odds-ratios of being above a given category k-1 (k=3) in the ordinal outcome are the same across categories when a covariate increases by one unit, I omit the two estimated cut points in Table 2.4.

varying covariates and the time-invariant fracking potential covariate. Listed first are coefficients and standard deviations for the fixed effects, or the estimated effects of a unit-change in each predictor within a state on the levels of regulation for that state, controlling for other factors. Listed below the fixed effects in the table are the random effects (i.e., between-state effects). These are the effects of a change in time-invariant features of states (i.e., the state-specific mean of each covariate) on regulation, after controlling for other observed variables. Between-state effects should be interpreted with more caution than those for the fixed-effects estimates of the time-variant variables because the between-state estimates do not control for unmeasured level-two heterogeneity between states (Vaisey and Miles 2017). I therefore discuss in this section the results for the fixed (within-state) effects of the covariates. I focus on Model 1 and Model 7, as they reflect the change in effects when considering only main effects compared to the interactions of the independent variables and the degree of fracking potential.[12]

[12] Model comparison statistics of Model 1 and Model 7 are mixed. The Akaike information criterion (AIC) favors Model 7 (300.5) to Model 1 (307.9), while the Bayesian information criterion (BIC), which favors parsimony and thus places added penalties for extra parameters, favors Model 1 (365.6) to Model 7 (394.2).

Table 2.4: Between-within Ordered Logistic Regression of Fracking Regulation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DV: regulation (3-category)							
Fixed (within) effects							
economic health	1.0004**	1.0005**	1.0005**	1.0005**	1.0005**	1.0004**	1.0006**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
govt liberalism	0.9446*	0.9205*	0.9444*	0.9447*	0.9470*	0.9445*	0.9187*
	(0.0223)	(0.0297)	(0.0230)	(0.0227)	(0.0214)	(0.0226)	(0.0308)
env mvmnt political contributions	0.8753	0.8657+	0.9445	0.8758	0.8800	0.8772	0.9334
	(0.0747)	(0.0748)	(0.1013)	(0.0755)	(0.0748)	(0.0748)	(0.1098)
oil-gas political contributions	1.3108*	1.3170*	1.3033*	1.3487*	1.3121*	1.3102*	1.3769+
	(0.1702)	(0.1750)	(0.1701)	(0.1980)	(0.1701)	(0.1698)	(0.2285)
oil-gas dependence	1.1272	1.1114	1.1153	1.0960	1.0632	1.3013	1.2508
	(0.2242)	(0.2244)	(0.2296)	(0.2335)	(0.2541)	(0.3016)	(0.2917)
env mvmnt org capacity	4.6147**	5.1126**	4.4584**	4.5939**	3.6623*	4.5345**	3.2497+
	(2.5096)	(2.7843)	(2.4051)	(2.4895)	(2.3210)	(2.4463)	(2.0291)
frack potentialXgovt liberalism		1.0007+					1.0011*
		(0.0004)					(0.0004)
frack potentialXenv polit contrib			0.9973				0.9973
			(0.0019)				(0.0021)
frack potentialXoil-gas contrib				0.9988			0.9980
				(0.0017)			(0.0021)
frack potentialXoil-gas dependence						0.9970	0.9931*
						(0.0020)	(0.0032)
frack potentialXenv mvmnt org capacity					1.0071		1.0192+
					(0.0078)		(0.0117)
Random (between) effects							
fracking potential[a]	1.0231+	1.0793**	0.8459**	0.7696	1.1253+	1.0723**	1.5827+
	(0.0134)	(0.0286)	(0.0470)	(0.1400)	(0.0800)	(0.0229)	(0.4074)
economic health	1.0001	1.0001	1.0001	1.0001	1.0002+	1.0002*	1.0003*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
govt liberalism	1.0600*	1.0927**	1.0799**	1.0717**	1.0591*	1.0605**	1.0398
	(0.0263)	(0.0314)	(0.0285)	(0.0278)	(0.0252)	(0.0211)	(0.0252)
env mvmnt political contributions	0.4860*	0.4335*	0.3061**	0.4796*	0.4613*	0.3423**	0.2274*
	(0.1684)	(0.1504)	(0.1198)	(0.1616)	(0.1687)	(0.1224)	(0.1454)
oil-gas political contributions	0.6665	0.5346	0.5966	0.4518+	0.5761	0.4919+	1.0042
	(0.2634)	(0.2249)	(0.2366)	(0.2105)	(0.2282)	(0.2064)	(0.5671)
oil-gas dependence	1.1627	1.2263	1.2882	1.2198	1.2763	2.6309**	3.8318*
	(0.2047)	(0.2233)	(0.2257)	(0.2111)	(0.2106)	(0.9838)	(2.3873)
env mvmnt org capacity	0.8708	0.8230	0.8550	0.8675	1.0980	0.8820	0.7560
	(0.1293)	(0.1229)	(0.1107)	(0.1246)	(0.2633)	(0.1016)	(0.1874)
frack potentialXgovt liberalism		0.9990*					1.0005
		(0.0005)					(0.0010)
frack potentialXenv polit contrib			1.0214**				1.0071
			(0.0072)				(0.0160)
frack potentialXoil-gas contrib				1.0235			0.9584+
				(0.0151)			(0.0240)
frack potentialXoil-gas dependence						0.9666**	0.9461*
						(0.0107)	(0.0230)
frack potentialXenv mvmnt org capacity					0.9861		1.0109
					(0.0097)		(0.0110)
est. random-intercept variance (ψ)	4.4080	4.2861	3.5401	4.1308	4.1833	2.5168	2.7983
	(2.7418)	(2.9618)	(2.3561)	(2.6474)	(2.6785)	(1.6444)	(1.8714)
Observations	272	272	272	272	272	272	272
Number of stateid	34	34	34	34	34	34	34
Panel-Clustered SEs	YES	YES	YES	YES	YES	YES	YES
Estimator	FGLS	FGLS	FGLS	FGLS	FGLS	FGLS	FGLS
Distrib. of random eff.	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian	Gaussian
integration points	16	16	16	16	16	16	16
n observations	272	272	272	272	272	272	272
n clusters	34	34	34	34	34	34	34
n parameters	16	18	18	18	18	18	26
model degrees of freedom	13	15	15	15	15	15	23
log-likelihood	-138	-134.8	-134.1	-137.1	-136.5	-130.6	-124.3
Wald chi2	33.24	36.68	36.18	37.05	39.25	37.94	100.5
p>chi2	0.0016	0.0014	0.0017	0.0013	0.0006	0.0009	0.0000
est. resid. intraclass correlation for y*_ij	0.5726	0.5658	0.5183	0.5567	0.5598	0.4334	0.4596

All covariates lagged one year. Coefficients reported as odds-ratios
Robust SEs in parentheses. ** p<0.01, * p<0.05, + p<0.1
[a]fracking potential is time-invariant covariate.

In the model with only main effects (Model 1), controlling for other variables, the estimated within-state effect of growth in the organizational capacity of the environmental movement is the strongest predictor of moving from a lower category of regulation to a higher one among the independent variables ($\beta=4.61$, $\rho<.01$).[13] This supports Hypothesis 2, which predicted that an increase in environmental movement organizational capacity in a state would positively correlate with stronger regulation. Although they are not as strong as the organizational capacity effect, contrary to the expectations of Hypotheses 4 and 1a, the main effects of oil-gas industry political contributions and government liberalism are the opposite direction as predicted. A one-unit increase within a state in liberalism on my 100-point ideology scale corresponds to an estimated 5.54% decrease in the odds of moving from a lower category of regulation to a higher category ($\beta=.9446$, $\rho<.05$). And a one-unit increase within a state of logged political contribution dollars corresponds to an estimated 31% increase in the odds of moving from a lower category of regulation to a higher category, net of other factors ($\beta=1.3108$, $\rho<.05$). Finally, the control of economic health is a strongly positive predictor of regulation ($\beta=1.004$, $\rho<.01$), implying that states in better economic condition are more likely to regulate fracking than poorer states. This is in line with theoretical expectations, as such states have less incentive to allow risky production activities that promise economic windfalls relative to comparatively poorer states.

While the within-state main effects are interesting in themselves, they do not account for the expectation that increased stakes—potential economic benefits but also potential social and environmental risks—will moderate the predicted main effects. The results from Model 7 address these questions. For example, while the main effect for government liberalism remains negative ($\beta=.9187$, $\rho<.05$), when I interact it with fracking potential, the effect for the interaction is significantly positive ($\beta=1.0011$, $\rho<.05$), meaning that in situations where economic and environmental stakes are higher, government liberalism corresponds to increased odds of regulation (compared to no regulation) or outright bans/moratoria on fracking (compared to simply regulation). Similarly, while the main effect for oil-gas dependence, as measured by the percentage of a state's GSP attributable to the oil and gas extraction sector, is not statistically significant, the interaction of oil-gas dependence and fracking potential is significantly negative ($\beta=.9931$, $\rho<.05$). This implies that, in the case of regulating industry interests by requiring information disclosure or banning the practice altogether, we can expect the predicted negative effect of a state's resource-dependence on industry in situations where more potentially frack-able resources are located in the state. Both of these interaction effects fit with the expectations of Hypothesis 5: 1) more ideologically liberal states may not exhibit the expected effects of more industry regulation until the threat of environmental and health risks become a salient issue because of increased potential for fracking, and 2) states heavily dependent on the oil-gas industry should expect industry to exert more influence on regulation when the economic stakes for industry increase. Finally, I note that the strongly positive estimated main effect of environmental organizational capacity from Model 1 is still positive in Model 7. However, the statistical significance of this relationship in Model 7 ($\beta=3.25$, $\rho=.059$) is weaker compared to that in Model 1 ($\beta=4.61$; $\rho=.005$). The interaction effect of organizational capacity and fracking potential is also positive, but it is weak enough that I cannot with 95% confidence reject the null

[13] Although multi-collinearity is not an issue here, the log-scale and presence of a few outliers in this measure exaggerate the estimated effect's odds-ratio (4.61), standard error (2.51), and width of the 95% confidence interval ($1.59<\beta< 13.40$). I will correct for this limitation in future robustness checks.

of no effect (β=1.02, ρ=.098).

4.3 Robustness checks

The models I report are robust to various alternative specifications and potential biases. First, specifying a probit link function yielded substantially similar results across models compared to the ordered logit link used in the models here. Second, as I described above, when compared to conventional random-effects models, my between-within modelling strategy offers the practical advantage of returning both within- and between-state estimates. However, a conventional random-effects model is more efficient—if it satisfies the assumption that both between- and within- effects are the same—because it uses a weighted average of the within- and between-cluster variation in estimation to provide a single effect estimate for each covariate. However, if this assumption does not hold, the estimates of the random-effects model are biased. To formally test whether my between-within approach is preferable to standard random-effects models, for each model reported, I conducted cumulative joint Wald tests of the null hypothesis that within-effect and between-effect coefficients for time-variant predictors are equal (*see* Allison 2009). Results confirmed that my approach is preferable to a standard random-effects model for both Model 1 ($\chi^2(7)=25.7$, ρ<.01), and Model 7 ($\chi^2(12)=27.91$, ρ<.01).

Estimates reported in Table 2.4 are also robust to alternative functions of the between-state effects. The between-within hybrid approach I used here can occasionally yield biased estimates when estimating multilevel models using a logit or other nonidentity link function (Brumback et al. 2010; Allison 2014). In these situations, one must assume that the random effects are linear functions of the cluster-level means. However, I checked for non-linearity by adding polynomial functions (squared and cubic) of the cluster-mean covariates, as suggested by Allison (2014). Doing so did not change the results of the time-variant coefficients in any significant way, and the only polynomial term that was statistically significant in itself was the measure of political contributions from the oil and gas industry (ρ<.05) (estimation results available upon request). These tests thus provide evidence that my model results are not biased.

2.5 Discussion and conclusion

My aim in this chapter was to conduct a comparative sub-national analysis of the effects of industry, social movements, and the broader political-economic environment on the regulation of controversial, risky economic activities in newly opened markets. In that way, it is intended to complement case-based studies of political/legal mobilization by, and contention between, industries and social movements (rarely both simultaneously) in emerging economic industries. Likewise, it complements other comparative approaches to governance of the economy, which are typically done at the international or else local levels and usually analyze the passage of legislation rather than the implementation of regulation.

Two limitations of this study should motivate future research. First, because of the immeasurably complex and, within states, overlapping regulatory regimes around dozens of aspects of fracking across states and over time, I used a simple measure of regulation—absence, presence, and ban/moratorium—as a measure of fracking regulation in this paper. I also used chemical disclosure regulation as a proxy for fracking regulation overall, which I justified in my discussion of chemical disclosure regulation above. However, future researchers can build on my approach in several ways. For example, they could, as I do in the next chapter, qualitatively code the content of regulations to get finer-grained measures of regulatory stringency. Extending my study in a different way, future research could delve into the social and economic causes and consequences of information-disclosure regulations and private governance, which I have not focused on here. One particularly fruitful avenue would be to conduct a comparative study of how different state-specific institutional legacies, industry pressure, and social-movement activism may have led to varying configurations of information-disclosure regulatory regimes (voluntary vs. required, variations in trade-secret protections, etc.) or variations in the construction, interpretation of, and compliance with disclosure regulations and private governance around fracking (Short and Toffel 2010; Yue et al. 2013).

Pitching the study at the state level and over a period of 8 years also comes at the cost of data limitations, as my measures of movement and industry influence are less direct than if I conducted a cross-sectional analysis or an in-depth qualitative analysis of one or a few communities or organizations. For example, my measures of movement influence only capture 1) the political mobilization of the environmental movement in terms of monetary political contributions from pro-environmental donors broadly defined, and 2) the organizational capacity of the environmental movement in terms of environmental organizational density in a state. Such measures do not take into account extra-institutional action, such as anti-fracking protests and civil disobedience, and do not directly measure anti-fracking activism but rather the broader environmental movement. The pragmatic hurdle of collecting precise protest data for each of the 34 states in the sample at each year of the study was beyond the scope of this chapter. I note, however, that researchers have justified the use of population density of SMOs as a measure to capture, albeit indirectly, the diversity of movement tactics, organizational forms, and actors on the rationale that areas with more SMOs are also more likely to exhibit such diversity (Johnson et al. 2010). And from a theoretical standpoint, the literature is mixed on the effectiveness of mass protest in influencing political/legal outcomes, with many arguing that such gains are usually more attributable to organizing than to protect actions (*see* Amenta et al. 2010).

In conclusion, this chapter contributes to the growing sociological literature bridging theories of social movements, organizations, politics, and markets. Unlike most studies in this line of research, I simultaneously tested influences of social-movement, industry, and contextual factors on state economic regulation rather than focusing on one or the other aspect. I also departed from conventional accounts by analyzing how these effects vary depending on how potentially profitable (and risky) the disruptive economic activity will be. When the stakes are raised in this way, I found that a state's resource-dependency on the industry to be regulated may make the state more vulnerable to regulatory capture, but in these situations of increased stakes, a state government's partisan ideology will also exhibit stronger effects on regulation, with a more liberal government ideology boosting the likelihood that a state will intervene in the market. Future research should build on my broad comparative approach to investigate more deeply the dynamics and mechanisms involved in the interactions between industries, movements, and the states tasked with governing economically beneficial but socially controversial economic innovations.

CHAPTER 3

FRACKING REGULATORY FIELDS: INTRA- AND INTERSTATE INFLUENCES ON REGULATORY STRINGENCY

Why do governments facing the same challenge—one involving innovative and highly technical economic production activities that simultaneously promise great benefits to local economies but pose substantial environmental risk—differ in how they regulate such a challenge? The rapid emergence of horizontal drilling and hydraulic fracturing stimulation techniques for oil and gas (hereinafter "fracking") in shale and other tight rock formations has challenged state governments, pressing them between the demands for economic development and revenues that fracking brings and the environmental risks and boom-bust potential that it poses. By examining intra- and interstate influences on the stringency of states' fracking chemical disclosure requirements, I depart from both conventional accounts of regulation, which typically focus on the behaviors of regulated organizations or the effectiveness of regulatory programs, and from conventional accounts of policy innovation, which typically examine factors affecting policy adoption rather than stringency. In doing so, I take a field-theoretic approach to explaining regulation in sub-federal policy domains, combining existing explanations of regulation into a single theoretical framework.

Consistent with regulation of oil and gas production historically, states, not the federal government, are the primary regulators of fracking activities. I focus on state regulations involving various aspects of chemical disclosure—the extent to which states require production firms to publicly disclose fracking chemicals. Building on research at the intersection of economic and political sociology, organizational theory, and the sociology of law, and taking a field-theoretic approach to state regulation, I generate hypotheses that could explain variation in how states regulate fracking chemical disclosure. I situate my analysis at the state level, covering the contiguous 48 states from 2008 (the first year that states began regulating fracking disclosure specifically) through 2016. The few existing empirical studies only assess influences on fracking regulation at a single point in time or else on one or a limited number of states (e.g., Davis 2012; Fisk 2013; Richardson et al. 2013; Rinfret, Cook, and Pautz 2014). To my knowledge, this is the first empirical study of fracking regulation that captures the dynamism of fracking regulations across the nation and over time.

I find that fossil-fuel resource availability, a state's historical position as an oil and gas producer, and, most importantly for this chapter, the degree to which a state's peer neighbors regulate fracking are the most influential predictors of increased regulatory stringency. These findings hold when controlling for other factors that scholarship suggests could influence regulatory stringency, such as political ideology, industry political influence, and economic hardship. In addition, although neither have independent effects, political influence from the energy industry moderates the effect of economic hardship; as campaign contribution dollars from industry increase, the negative effect of economic hardship on regulatory stringency becomes much stronger.

My field-theoretic framework offers a richer avenue to explain both internal and external pressures on regulation than existing accounts of state regulatory influences. State governments, operating in regional fields with neighboring states, are most strongly influenced by the actions of their nearby peers. However, as the energy industry, which operates within a state's political field, increases its influence through monetary contributions, states in relatively poor economic health are increasingly susceptible to that influence and implement less stringent regulations.

I organize the chapter as follows. First, I discuss issues of regulation that have arisen because of fracking, focusing on chemical disclosure. After describing the panel dataset and analytic strategy, I estimate models to understand the influence of inter- and intrastate factors on the stringency of disclosure regulation. I review the findings and conclude by discussing the chapter's contributions to theories of regulation and the public interest in understanding state-level governance of highly technical, disruptive activities.

3.1 Regulation of fracking

Despite a wealth of localized case studies, we lack a national, longitudinal assessment of how states, have responded to the fracking boom via regulation. Aside from a few specific issues governed by federal law (see Ratner and Tiemann 2015), the regulation of fracking-related production activities has been left to the states.[14] Because conventional oil and gas production had occurred in many states prior to the fracking boom, most states already had general oil and gas regulations and statutes in place prior to the 2000s. However, all states have faced at least the *possibility* of regulatory innovation and change because fracking brings major economic and environmental disruption and involves novel, fracking-specific extraction activities.

I describe in detail the type of regulation that I study—chemical disclosure requirements—in section 3.2 below. Based on my review of state laws between 2009 and 2016, 29 states implemented new or revised existing statutes or regulations specifically to address fracking chemical disclosure.[15] Another five placed a moratorium on fracking or else banned fracking altogether during at least one year of the study period.[16] By the end of 2016, 29 states had some form of disclosure requirement, with an additional state having a moratorium on drilling (Maryland) and two others banning fracking altogether (New York; Vermont). Figure 2.1 (Chapter 2) depicts the states that had adopted disclosure regulations, fracking moratoria, and bans by the end of the first and last year of my study period. However, it only depicts the presence or absence of regulation. Yet to be understood are the factors that explain variation in the content of regulation, specifically variation in how *stringently* states regulate fracking. This is the primary task of this paper.

3.2 Theorizing Regulatory Stringency

That there is a fundamental relationship between the economy and the state is a founding principle of sociology. Weber (1978:337) argued that the form of legal-rational capitalism that arose in the modern West necessarily requires a "promptly and predictably functioning legal system," such as property rights and state-enforced contract laws, in order to thrive. Polányi (1944) dispelled the myth of the "free" market, showing how modern capitalist economies at least depend on the state to supply and regulate fictitious commodities of land, labor, and money. And he argued that tensions between two competing movements—the drive for laissez-faire and market expansion on one hand and the movement for socio-environmental protection from market forces on the other—affect economic regulation in market societies.

More recently, sociologists have empirically tested and built upon these theories, showing how states, politics, and economic institutions mutually constitute one another (e.g., Dobbin 1994; Evans 1996; Fligstein and Stone Sweet 2002). However, as Edelman and Stryker (2005:528) point out, "law is [still] not often a sustained object of inquiry in its own right,"

[14] States also vary in their regulation of non-production-related activities, such as fracking wastewater disposal, storage and transportation of fossil fuels after production, well-plugging and well-abandonment, etc. I limit analysis in this paper to regulation of fracturing fluid chemical disclosure.

[15] Alabama, Alaska, Arkansas, California, Colorado, Idaho, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Montana, Nebraska, Nevada, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, and Wyoming.

[16] Maryland, New Jersey, New York, North Carolina, and Vermont.

especially in economic sociology. The literature on organizations, particularly institutionalist research, does better, but it rarely engages with or accounts for the federalist nature of many legal systems. True, a few historical studies assess how states within a nation governed an economic shock (Dobbin and Dowd 2000) or how institutional factors across states and over time mediated market- and interest group-based influences on policy adoption (Schneiberg and Bartley 2001). Missing among even these, however, are studies that closely examine the *content* of state statutes and regulations in order to understand the nuanced differences in regulatory stringency among states (see Vasseur 2014). Moreover, they do not address regulatory responses to shocks in which the disruptive economic event is still developing and left mostly unregulated by a federal government, thus leaving the states-within-the-state as sites for the still-evolving question of economic regulation to play out. State fracking chemical disclosure regulation provides an ideal case to study how multiple and multilevel institutional factors influence how stringently American states regulate risky economic activity in the twenty-first century.

To explain this ongoing case of state-level regulation, I draw from organizational theory, political sociology, economic sociology, and the sociology of law (e.g., Laumann and Knoke 1987; Dobbin 1994; Fligstein 200l; Andrews and Edwards 2004; Edelman and Stryker 2005; Schneiberg and Bartley 2008). Building on scholarship in political science examining state-level policy innovation and diffusion (e.g., Walker 1969; Berry and Berry 1990; Graham et al. 2013), I add a sociological account of factors influencing regulatory stringency (as opposed to simply adoption). Finally, I contribute to a burgeoning literature in legal scholarship (e.g., Wiseman 2013) and policy studies (e.g., Rabe 2014) assessing connections between institutions, contemporary energy production, and regulation.

Fields of State Regulation

To bridge these various approaches to regulation, I use field theory as an orienting framework. Specifically, I build on Fligstein and McAdam's (2012) recently developed variant of field theory, which links structure, agency, and social change to explain how "strategic action fields" order social life.[17] Fields are socially constructed arenas in which actors cooperate and compete over material and symbolic resources. More specifically, Fligstein and McAdam (2011:3) define a strategic action field as "a meso-level social order where actors (who can be individual or collective) interact with knowledge of one another under a set of common understandings about the purposes of the field, the relationships in the field (including who has power and why), and the field's rules." When centered around an identifiable issue of policy and governance, a field is akin to a "policy domain," which is occupied by a set of actors who formulate and select courses of action about a substantive area of mutual relevance and whose disclosed intentions and actions are taken into account by other domain participants (Laumann and Knoke 1987:10-11).[18] This is consistent with a fields-based view of policymaking, as groups and coalitions struggle for influence and the ability to institutionalize their views into laws and regulations (Sabatier 1988; Schneiberg and Soule 2005; Barley 2010).

Field theory posits that economically disruptive activities or events will increase the likelihood that a state will intervene and impose order through policies and regulation (Fligstein

[17] Fligstein and McAdam's framework builds on and extends prior field-theoretic accounts in sociology, most notably the "organizational fields" proposed by DiMaggio and Powell (1983) and Bourdieu's conception of social fields (see Kluttz and Fligstein 2016).
[18] I use the terms "field" and "policy domain" interchangeably in this paper to identify the set of actors and institutional conditions particular to a given state that influence the regulation of fracking.

and McAdam 2011:19). Disruptive economic events, such as economic downturns or, as in my case, an energy production boom, disrupt the status quo of markets and policy domains (Fligstein 2001). The potential thus increases for actors to shift their positions relative to others, inhabit newly opened social spaces, and even change the “rules of the game” that guide action. This logic applies not only to firms (producers, consumers, suppliers, etc.) but also to state governments (Fligstein 2001; Baumgartner and Jones 2009).

Internal and External Influences on Regulatory Stringency

Research on state-level policymaking in both political science (e.g., Berry and Berry 1990) and sociology (e.g., Schneiberg and Bartley 2001; Soule and Earl 2001) shows that, depending on the type of policy and contextual factors, policy adoption is influenced by two broad kinds of mechanisms—internal (intrastate) factors bounded within a single state and external (interstate) influences emanating from outside from outside the state.[19] I apply this framework not to examine policy adoption but rather the *stringency* of regulation.

Influences from within the state

State officials may enact legislation or issue regulations due to internal (intrastate) influences— economic, political, and sociodemographic factors that operate outside of legislative chambers and regulatory agency offices but firmly within the state arena. Intrastate factors include state political elite ideology, the influence of interest groups within a state, and economic hardship.

Political ideology. Cultural sociologists and institutional scholars often start with the idea that actors, including governments, aim to minimize uncertainty and impose order. They do so by drawing on existing cultural schemas and beliefs, especially when confronting novel or complex situations (Swidler 1986; Fligstein 2001; Scott 2008). The cultural beliefs of state government actors thus should influence how they design laws and rules governing novel and complex activities. Moreover, institutional approaches to policymaking recognize that political decision-makers define, interpret, and carry out economic policies not simply according to their strategic interests in being re-elected or appointed but also in accordance with their political identity and ideology (Dobbin 1994; Fligstein 1996; Campbell 1998). Any discussion of American state political ideology starts with the familiar liberal-conservative continuum (Berry et al. 1998, Shor and McCarty 2011). In the American context, and relative to conservatives, liberals generally prefer more government intervention in markets and more stringent regulation of environmentally risky business activities. I thus expect an independent effect of political elites’ collective ideology on the stringency of regulation.

> *H1: The more liberal a state’s government ideology, the more stringent its regulations toward economic producers.*

Industry influence. Drawing on economic theories of regulatory capture, a simple explanation of regulatory stringency is naked self-interest. For decades, theories of regulatory capture emanating from the Chicago school of law and economics have dominated academic literature on the topic (e.g., Stigler 1971; Peltzman 1976; Becker 1983). The basic premise of the law-and-economics approach is that those with the most vested interest in a regulated activity (i.e., the business sector) will work hardest to pursue their interests by shaping regulation, most often by offering material incentives or disincentives to politicians and regulators in exchange for favorable treatment. For their part, legislators and regulators look to attain such resources and

[19] From a field-theoretic perspective, state governments themselves exist in a broader, national-level field or policy domain that is centered around a common issue (Hoffman 1999).

avoid the disincentives of losing business, as both ultimately help them get re-elected, re-appointed, or promoted. Thus, the argument goes, regulatory capture by industry is more or less assured and, accordingly, increased regulation is rarely preferred over competitive market forces. The underlying assumption of this logic is that actors involved on all sides are motivated foremost by their material self-interest.

Of course, the idea that corporate elites and businesses use a privileged position to influence policy and regulation is well-established in sociology (e.g., Mills 1956; Domhoff 1967; Useem 1984). In particular, resource dependencies structure relations among organizations; as a firm becomes increasingly dependent on another for critical resources, it can become increasingly subject to that firm's influence (Pfeffer and Salancik 1977). For an industry-state relationship, a similar logic applies: the more dependent the state on an industry for resources, the more influence that industry should have on state policies relevant to its business interests.

Not surprisingly, then, industry actors who stand to gain from fracking advocate for decreased regulatory oversight by the state. Speaking at an industry event in 2012, for example, the CEO of the American Petroleum Institute, the largest trade association for the oil and gas industry, summed up this view:

> You can't be for the potential energy development in the United States and be against hydraulic fracturing. You fundamentally can't regulate the very technology that has created the potential and deny the ability to use that in places where we can see job creation, revenue creation (quoted in Fischler 2012).

The economic disruption brought about by fracking has thus created an opportunity for stakeholders, particularly the oil and gas industry, to influence regulation by advocating for decreased regulatory stringency (see Rinfret et al. 2014). The main avenue for exerting such influence is through supplying material resources to state political actors, principally through monetary political contributions. Although research is mixed on whether monetary contributions are always the most effective means for an industry to obtain desired policy results (Burstein and Linton 2002), material resource-dependency, in the form of monetary political contributions, continues to be a principal way that industries exert influence on political and regulatory outcomes (Fligstein 2001; Walker and Rea 2014).

> *H2: The greater the material influence of oil and gas industry in a state, the less stringently the state will regulate fracking.*

Influences from outside the state

In field-theoretic terms, states take one another into account and act in accordance with the expectations and norms set by their field environment (Fligstein and McAdam 2012). This view resonates with insights from organizations and social-movements scholarship, in which organizations (including governments) may emulate or converge toward their peers' decisions as ideas diffuse across the environment and to appear legitimate among peers (Soule and Earl 2001; Schneiberg and Clemens 2006:202). This is also in line with one of the earliest and most consistently found drivers of adoption in the policy literature—diffusion across geographically proximate peers as jurisdictions emulate their neighbors' policy decisions (Walker 1969; Berry and Berry 1990; Mooney 2001; see Berry and Berry 2014). Studies assessing such regional effects on regulatory stringency, rather than the binary outcome of adoption, are scarce. However, in the realm of environmental regulation, survey research has shown that state environmental officials, on average, "strongly" agree with the idea that their regulatory standards should be of about the same stringency as those of neighboring states (Engel 1997:344).

Despite a burgeoning academic literature on fracking, one leading scholar of fracking policy recently noted that there remains a "dearth of empirical work on cross-state variation in fracking policies" (Davis 2017), much less on the effects of peer states' actions on regulatory stringency. However, there have been some efforts, mostly by policy scholars, to examine fracking governance more narrowly, whether through cross-sectional surveys of a limited number of state laws, case studies, or comparisons of local ordinances within one state (e.g., Fisk 2013; Heikkila et al. 2014; Rinfret et al. 2014; Dokshin 2016; Arnold and Neupane 2017). Evidence from studies at the local level suggests that the greater the number of geographically proximate jurisdictions adopting a given policy position, the more likely a focal municipality will be influenced to follow those neighbors' position, whether it be pro-fracking ordinances (Arnold and Neupane 2017) or anti-fracking measures (Dokshin 2016). It is an open question as to whether such findings extend beyond municipalities and adoption to the state level and regulatory stringency (instead of policy adoption). While Wiseman (2014) argues that, on the whole, state governments look to other states' fracking regulations less than one might expect, her interviews with government officials and regulators indicate that, when they do consider others in the policymaking process, they often look to neighbors for guidance. Based on these prior findings, I expect neighboring states to be particularly influential drivers of fracking regulatory stringency because states in close proximity are likely to share similar geological characteristics, cultures, and historical experiences with the energy industry than with distant states. Thus, I predict that a state's regulatory stringency will be positively influenced by how stringently its peer states regulate the same issue.

> *H3: The greater the average stringency of a state's peers' regulation of a given issue, the greater the stringency of the focal state's regulation of that issue.*

3.3 Research Design, Data, and Methods

Empirical Setting

To analyze state regulatory responses to disruption, I study the contiguous 48 states from 2009 to 2016.[20] This period coincides with the beginning of large-scale fracking outside Texas's Barnett Shale up and ends with the most recent year that all data are available. In addition, 2008 is the first year that a state directly and specifically addressed fracking via regulation (statistical analysis begins at 2009 because I use one-year lagged predictors). The unit of analysis is the state-year (n=384). I include all contiguous 48 states, instead of only the 29 states that overlay shale plays, to avoid selection bias.[21] Table 3.1 describes constructs and measures.

[20] Alaska and Hawaii have missing data limitations, and due to their geographic locations, they lack many of the regional and geological features necessary for my measures.

[21] If I included only states with shale plays, I would exclude states that regulate fracking even though fracking may not be occurring. As I discuss below, to account for this, I include a control for percentage of state total surface area over a shale play.

Table 3.1: Constructs and Measures

Construct	Measure
Dependent Variables	
Disclosure stringency	Index of state regulatory chemical disclosure stringency*
Indep. Variables	
Political ideology (H1)	State govt. ideology (higher score = more liberal)
Industry influence (H2)	Logged dollars contributed by oil & gas industry to state political campaigns and committees
Peer stringency (H3)	Average stringency of peer states' regulation in PADD district
Controls	
Economic hardship	Annual unemployment rate (unemployed as % of civilian labor force)
Shale play presence	% of state total area over a shale play
Historical oil+gas production	Average state ranking in oil + natural gas production from 1960 to 1999 (higher rank = more oil+gas produced)

*See text for description of the five disclosure components used to calculate the index.

Dependent Variable: Chemical Disclosure Regulation Stringency

Fracking chemical disclosure regulations require well operators to disclose the potentially toxic chemical mixtures they add to the water that fractures shale rock. For example, hundreds of chemicals that are known or possible human carcinogens have been used in fracking operations (see Murrill and Vann 2012; Centner 2013). One can view fracking chemical disclosure requirements disclosure regulations from several perspectives. First, with these requirements, lawmakers conceive of the public as having a right to know whether energy firms are engaging in activities potentially harmful to health and the environment (Stephan 2002). In this way, chemical disclosure requirements are based on shaming and public-monitoring mechanisms at play when firms are required to disclose potentially harmful information that the public can then use to understand industry activities and/or organize politically (Hadden 1989; Fung et al. 2007). Relatedly, chemical disclosure regulations in the fracking context are a soft form of ‘regulation by information’ (Schneiberg and Bartley 2008:43), wherein the state takes an indirect role by delegating oversight and/or sanctioning to quasi-state entities, the public, or the oil and gas industry itself (e.g., FracFocus, discussed below). Finally, one can conceive of disclosure requirements as designed to lessen information asymmetries between industry, the public, and the state, thereby reducing the public’s information-seeking costs that intellectual property laws and lack of technical expertise impose (Wiseman 2011). In this way, a chemical disclosure requirement is a kind of social welfare policy in that it aims to protect the public from the risk of groundwater contamination.

Chemical disclosure requirements are particularly useful to analyze for several reasons. First, they often suggest multiple ways to comply and thus provide opportunities for researchers to capture variation in how firms respond. Second, fracking chemical disclosure regulations have practical theoretical and methodological advantages. Unlike other oil and gas regulations that existed prior to fracking and were applied to this new activity, they are specific to fracking. Thus, the regulations in my dataset are policy innovations for the focal state and can be examined without assumptions as to their crafters’ intentions in applying them to the economic activity under study. Third, chemical disclosure is one of the most contested and discussed regulatory issue surrounding fracking (e.g., Wiseman 2011; Murrill and Vann 2012; Furlow and Snow 2012; Centner 2013; Fisk 2013; Gosman 2013; McFeeley 2014; Konschnick and Dayalu

2016). To collect chemical disclosure laws and regulations, I searched each state's legal and regulatory archives on legal databases (LexisNexis and Westlaw) and state websites for the enactment and content of state regulations and laws at the end of each year of my study period.

I measured chemical disclosure stringency with an index that incorporates five components of disclosure requirements. The first component is a dummy indicating whether a state had no fracking-specific chemical disclosure regulation whatsoever or a regulation in place. Second, following McFeeley's (2014) cross-sectional survey of disclosure requirements for selected states, an ordinal measure codes regulations based on their required method of chemical disclosure: require no disclosure at all, only require well operators to disclose chemicals to a privately managed online registry called FracFocus[22] or else give operators the option to submit to FracFocus *or* the state, require operators to disclose to the state but not require them to submit to FracFocus, and require disclosure to the state *and* to FracFocus. These are in ascending order of stringency because the latter two categories make the disclosures subject to state recordkeeping laws and thus make operators more accountable to produce complete and timely reports (McFeeley 2014), while the final category gives the public an added level of access to information beyond the state.

For the third component, a dummy indicates the presence of a post-fracking disclosure requirement. Fourth, a dummy indicates whether a state requires, in addition to post-fracking disclosure, a disclosure from operators submitted *prior* to commencing fracking operations. This is a more onerous requirement for operators than only post-fracking disclosure. Fifth, I recorded the number of days, as measured from the completion of fracking stimulation treatment, that operators are allowed until they must submit their disclosures.[23] In this case, a higher number of days indicates a less stringent regulation. For states with no disclosure requirement, I coded their number of days to 365 days, on the grounds that one year indicates a very lenient, but not unrealistic, disclosure period relative to the longest duration observed in the year (90 days). For states with a moratorium or ban in place on fracking during the focal year, I coded the number of

[22] FracFocus is a joint project of two non-government entities – the Groundwater Protection Council and the Interstate Oil and Gas Compact Commission, an industry group. For an overview of FracFocus and discussion of its effectiveness as a publicly available registry, see Konschnick and Dayalu (2016).

[23] For the few states that measure the number of days based on a reference point other than the time at which operators complete fracture stimulation treatment (the most common reference point), I normalized the disclosure duration period to the common starting point of when fracture stimulation treatment ceases. For example, Kansas requires chemical disclosure within 120 days *from the date the well is drilled* (the "spud date") (*see* Kan. Admin. Regs. s. 82-3-1401 (2013)). Based on my review of industry literature and a sample of well-completion reports from Kanas wells drilled after 2011 at total depths greater than 4,000 feet, I assume an industry-average of 60 days from spud date to conclusion of fracturing stimulation for horizontal wells in Kansas, thereby subtracting 60 days from the 120 days specified in the regulation. For states that calculate chemical-disclosure reporting time limits *from the date of well-completion* (e.g., Arkansas Admin. Code 178.00.1-B-19(l) (2011); N.M. Admin. Code 19.15.16.19(b) (2012)), I assume that well-completion and conclusion of fracturing stimulation occur on the same date, as fracturing is often the final phase of completion. In Pennsylvania, the applicable regulatory provisions, in effect since 2011, require some stimulation-treatment disclosures to be reported to the regulatory agency within 30 days of well-completion (see 25 Pa. Code § 78.122(b) (West 2011), while the applicable statutory provisions, in effect since 2012, impose additional disclosure requirements (e.g., submission to FracFocus) within 60 days of the conclusion of hydraulic fracturing treatment (see 58 Pa. Const. Stat. s. 3222.1 (West 2012)). Here, I coded all timing requirements since 2011 as 30 days from well-completion and coded disclosure access up to 2011 as slightly less stringent (x=2) than access since 2012 (x=3).

days as equal to the minimum post-fracking disclosure time requirement observed in a given year (30 days for 2009-2010; 20 days for 2011-2014; 15 days for 2015-2016).

As a group, the five disclosure stringency components are internally consistent (Cronbach's alpha=.95). I thus used principal components analysis to compute a single disclosure stringency index (four factor loadings >.93, pre-fracking dummy loading=.74).

Internal influences

Political ideology. To measure ideology, I employed a widely used scale of state government ideology (for a list of publications using this measure, see Berry et al. 2013:165). The scale aggregates political leaders' ideologies to the state-level to capture the conservative-liberal continuum of state governments as a whole. Originally developed by Berry et al. (1998) and revised twice to improve validity and coverage (Berry et al. 2010; Berry et al. 2013), it is a weighted average of the ideological positions of five political institutions in each state: the Democratic and Republican delegations in the state's lower and upper chambers and the state governor.[24] Each congressional chamber's score is itself based on a combination of its members' ideal point estimations, using data from Project Votesmart's annual survey of state legislative candidates (the National Political Awareness Test; now called the Political Courage Test), and each party's share of seats it controls in each chamber. Scores fall on a continuum, with zero representing the most conservative position and 100 the most liberal.[25]

Industry influence. Material resources donated to government actors yield influence and political power for donors. Thus, to measure industry influence, I used annual, state-level political contribution data obtained from the National Institute on Money in State Politics (NIMSP 2017). The accuracy and coverage of these publicly available data have been verified by scholars (Bender 2013). The NIMSP provides detailed information on donors for each contribution and the industry/sector from which it came.

For each state-year, I recorded the total dollars contributed by the oil and gas sector. I adjusted the figures to chained 2009 dollars using the annual average Consumer Price Index for all urban consumers (US BLS 2016b). Only eighteen of the total 384 state-year observations from 2008 to 2015 were missing data.[26] I used nearest-neighbor interpolation to fill in data for missing years. Finally, I calculated the natural log of each observation for use in the models

[24] The measure accounts for Nebraska's unicameral legislature. For an alternative annual measure of state government and state legislator ideology as a robustness check, I used Shor and McCarty's (2011) ideology indicator. The two measures did not differ significantly. I opted for the Berry et al. (2013) measure both because it includes the ideology of each state's governor in its score (making it a more direct measure of each state government as a whole) and because it provided data coverage for more years than the alternative measure.

[25] The ideology data have been updated through 2014. I repeat the 2014 data for the missing 2015 data in my models. As a robustness check, I also included a measure of state *citizen* ideology, also originally developed by Berry et al. (1998) and updated through 2014. Because its inclusion made no substantive difference in my models, and because of collinearity issues with the government ideology measure (r=.55), I omitted it from reported models.

[26] As with other variables, I use data from 2008 to 2015 to account for the one-year lagged predictors. As of the date that I collected contribution data (January 23, 2017), NIMSP reported that 99% of available state and federal contribution records from the oil and gas industry were included in its database. The 18 missing observations were all in non-election years: eight in 2009, four in 2011, four in 2013, and two in 2015.

reported below.[27]

External influences

To measure external, interstate influences on the stringency of a state's regulation (Hypothesis 3), I classified states into neighboring peer groups. Rather than simply assuming that bordering states make up a state's peers, but in order to account for the shared shale geology so important for fracking in shale formations, I used Petroleum Administration for Defense Districts (PADDs) as regions. Department of Energy officials and other analysts employ PADDs to organize states into groups based on shared geographic and energy-infrastructure attributes (US EIA 2012). There are five PADDs encompassing the contiguous 48 states, with one district subdivided into three sub-districts, yielding seven total districts. Figure 3.1 depicts the seven PADDs used in the analysis. For each state-year, I calculated the average stringency score for a region (excluding the focal state). I then used the region's lagged (one-year) average stringency score as a predictor in the models.

Figure 3.1: US Department of Energy PADD regions

PADDs originated with the Petroleum Administration for War, which was created by executive order after the US entered World War II. During the war, this organization was responsible for allocating fuels derived from petroleum products, regulating fuel prices, and subsidizing oil and gas exploration and production. The government disbanded the organization

[27] As a robustness check, I used two alternative but less direct measures of interest-group influence. First, to capture environmental group influence, I measured each state's number of active environmental nonprofit organizations (per 100,000 residents) at each year. Environmental nonprofit organizations are defined as those registered with the IRS as a 501(c) exempt organization in a given state-year and whose purpose is classified by the IRS as "Environmental Quality, Protection & Beautification" under the National Taxonomy for Exempt Entities system (NTEE-CC major group "C"). I obtained data from the Urban Institute's National Center for Charitable Statistics, which compiles such data from the IRS Business Master Files (NCCS 2017). Second, to capture the influence of the oil and gas industry in a state, I collected crude oil and natural gas production data from the Department of Energy's State Energy Data System, a publicly available database with annual data on each state covering the entire study period (US EIA 2014c). I then converted the figures for crude oil produced and natural gas produced (excluding fuel ethanol) to a common metric (BTUs), added them, divided by two to obtain an average, then expressed that figure as a percentage of total US oil and gas produced for that year. The environmental group indicator was not statistically significant, and while this alternative industry influence variable was mildly negatively significant, it was highly collinear with historical production.

after the war, but Congress passed the Defense Production Act in 1950, which created the Petroleum Administration for Defense and used the same five regions. Today, government officials and market analysts often use PADDs to collect regional energy data and understand the supply, demand, and movement of domestic energy (e.g., US EIA 2015c; US EIA 2015d).

Although grouping states into any pre-defined regions presents limitations at the regional borders, my regional measure of PADDs is particularly well suited for my case of fracking disclosure regulations. It captures a desirable combination of shared regional geology (shale characteristics), political history and culture, energy infrastructure, geographic proximity. First, neighboring states often share the important geological features of shale formations. Of course, PADD borders do not completely mirror shale area borders, but they come remarkably close (compare Figures 4 and 5). For example, PADD 3 (Gulf Coast) states share largely self-contained (at the PADD level) basins such as the Permian Basin, the TX-LA-MS Salt Basin, and the Black Warrior Basin. Second, although PADD borders do not capture every state's contiguous neighbors, they are nevertheless based on geographic proximity, and a long-standing literature on regional political subculture shows that states are more likely to share similar political and cultural characteristics with neighboring states than non-neighbors (Elazar 1966; Lieske 2010).[28]

Third, PADDs are based on energy-related characteristics like energy infrastructure, production, and consumption that are still relevant today, thereby making the PADD measure a more direct measure of state regions in the fracking context than other grouping methods. For example, it makes sense that Oklahoma is in the Midwest PADD and not the Gulf Coast PADD because Gulf Coast states house many of the nation's refineries near Gulf Coast ports and because much of the petroleum traveling through Midwest states south to those Gulf Coast refineries flows through pipelines that meet at the hub oil-storage town of Cushing, Oklahoma.

Finally, because neighboring states make up each PADD, the measure accounts for the importance of geographic proximity to state government officials looking for information on other state policies when designing their own laws. Indeed, the majority of policy scholars agree that geographic proximity is a crucial factor for diffusion and include some measure of it models (e.g., Berry and Berry 1990; Mooney 2001), while a minority argue that national organizations and non-geographically based groupings are more important influences in today's information-rich policy environment (e.g., Karch 2007:140). Most directly related to my own case, prior survey work shows that, on average, state regulators agree that their environmental standards should be of about the same stringency as those of neighboring states (Engel 1997). Fracking chemical disclosure regulation is an environmental regulation because it aims at identifying chemicals used in fracking that could contaminate groundwater supplies.

Controls

Economic hardship. A state facing economic hardship may respond strategically to its situation and seek to boost its economic plight by easing regulatory restrictions on industrial production. A similar logic applies to social movements and community responses to potentially harmful industrial sitings, including energy-infrastructure projects, wherein economic hardship reduces community motivation to oppose such projects (Wright and Boudet 2012). In the regulatory context, this type of response is also based in part on the assumption of regulatory

[28] Nevertheless, as a robustness check, I used a measure of the average stringency of a state's geographically adjacent neighbors instead of its PADD-region neighbors in models. This did not substantively change the findings I present below.

arbitrage, in which states recognize that businesses will avoid investment in a state with relatively restrictive regulations (for a review, see Carruthers and Lamoreaux 2016). Under this reasoning, a state would aim to avoid this situation, particularly in economically stressful times.

A common assertion of the energy industry and fracking supporters is that drilling activity brings economic growth to a state in the form of increased employment and tax revenue (Fischler 2012). Thus, we should expect that the more economically depressed a state, the less restrictive its policies will be on the oil and gas industry. I measured economic hardship with a state's unemployment rate (lagged one year). I gathered annual unemployment rates of each state's civilian non-institutionalized population from the BLS's Local Area Unemployment Statistics program (US BLS 2016a). States with higher unemployment should have less stringent regulation.

State geology. An assessment of regulatory policies toward fracking should control for geological variation among states. The less unconventional natural gas or oil sources in a state, the less stringently it should regulate fracking because the amount of potential fracking activity should decrease as the amount of source rock decreases. Following standard approaches toward understanding the recent boom in unconventional oil and gas production (e.g., US EIA 2013b), I focus on hydraulic fracturing in shale formations only. Although the well-stimulation technique of hydraulic fracturing can be applied in other low-permeability sources such as "tight" sandstone and carbonate (or a mixture of these with shale) and even some conventional source formations, researchers and energy officials overwhelmingly attribute the US energy boom during the 2000s to exploration and production from shale (Ratner and Tiemann 2015:2; US EIA 2014b: MT-23).[29] Thus, for analytical purposes in bounding geographical areas with possible fracking, I consider shale as the source rock for shale-gas and tight-oil fracking.

Using geospatial data from the US EIA (2016b), I identified the shale formations across the United States. Because shale plays capture the areas in which fracking is most likely to occur, I created a variable indicating the percentage of a state's total surface area over a shale play. As of the EIA's March 2016 assessment, 29 of the contiguous 48 states had some percentage of their surface area overlaying shale plays.

Historical importance of oil and gas production to state. Previous research suggests that communities with prior histories of oil and gas development are more likely to support fracking in their area (Wright and Boudet 2012; Dokshin 2016). To capture the historical importance of fossil-fuel production in a state, I collected data on the annual amount of crude oil and marketed natural gas produced in each state during the 40 years prior to the rise of any commercially viable fracking methods (1960-1999). Converting the annual oil and gas figures to a common metric (BTUs) and adding them together, I then expressed the sum as a rank of that state compared to the other 47 states during that year (higher rank=more oil and gas produced). I calculated the 40-year average rank for each state in order to capture the historical level of oil and gas production relative to other states over the last four decades.[30]

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[29] With natural gas, for example, I do not include resources in other unconventional sources, such as coalbed methane from coal seams or tight gas from non-shale sources, as "frackable" because they have not affected total U.S. natural gas production during my study period nearly as dramatically as shale gas.

[30] Alternative measures capturing the historical importance of oil and gas production to a state's economy (e.g., logged historical production figures, historical state ranks in production using periods besides 1960-1999) did not substantively change the results.

Analytic strategy

The unit of analysis for the longitudinal panel dataset is the state-year. I conduct analyses on the 48 contiguous states from 2009 to 2016 (n=384 state-years). I use a "between-within" modeling approach, which as a method for analyzing panel and multilevel data embeds a fixed-effects estimator within the framework of a random-effects mixed model (Allison 2009:23-25; Vaisey and Miles 2017).[31] Treating unit-level (i.e., state-year) observations as clustered within states, I include as covariates in the model both the cluster-specific mean of each variable and the deviation from that cluster-specific mean (i.e., group mean-centering), thereby allowing me to obtain unbiased estimates of between-cluster and within-cluster effects, respectively, for the time-varying (level-one) predictors of political ideology, industry influence, peer stringency, and economic hardship. Unlike conventional fixed-effects estimation strategies, the use of a random-effects estimator also enables me to obtain unbiased estimates for the important time-invariant (level-two) predictors of state geology and historical production rank.[32] I include year fixed effects in all models and lag all time-varying predictors one year to avoid reverse causality. I express the model for main effects as:

$$Y_{it} = \alpha + \beta_1 X_i + \beta_2 (XT_{it} - \overline{XT}_i) + \beta_3 \overline{XT}_i + \beta_4 X_t + \zeta_i + \epsilon_{it} \quad (1)$$
$$\zeta_i | x_{it} \sim N(0, \psi)$$
$$\epsilon_{it} | x_{it}, \zeta_j \sim N(0, \theta)$$

where Y is the outcome of disclosure regulation stringency for each state *i* at year *t*, $\beta_1 X_i$ represents the effect of the vector of time-invariant predictors *X*, $\beta_2(XT_{it} - \overline{XT}_i)$ represents the within-state effect of the vector of time-varying predictors *XT*, $\beta_3 \overline{XT}_i$ represents the between-state effect of these time-varying predictors, and $\beta_4 X_t$ represents year fixed-effects by including a dummy for each year from 2010 to 2016. The model allows each state cluster *i* to have its own intercept and splits the total error into a cluster-level error ζ_i and unit-level error ϵ_{it}. ψ is the between-cluster variance and θ is the within-cluster variance. ζ_i and ϵ_{it} are assumed to be independent over clusters *i*, independent of observations x_{it}, and independent of each other. The unit-level error term ϵ_{it} is assumed independent over years *t*.

I report Huber-White state-clustered robust standard errors in all models to correct for panel-level heteroskedasticity. For each model of interest, Pesaran's (2004) post-estimation test for cross-sectional dependence suggested insufficient evidence to reject the null hypothesis that the error terms are independent across entities (all p-values > 0.40). For the full model (Model 4, below), cumulative joint Wald tests of the hypothesis that within-effects and between-effects for time-variant predictors are equal confirm that my between-within approach is preferable to a standard random-effects model (χ^2=18.58, df=5, ρ<.01).

3.4 Results

Descriptive Statistics

Table 3.2 shows descriptive statistics for all variables. Because I use one-year lagged predictors in analyses, statistics for the predictors cover 2008-2015 and 2009-2016 for the dependent variable. The disclosure stringency index ranges from -0.79 (various state-years with no regulation at all) to 1.69 (state-years with moratoriums or bans on fracking). Of states with a

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[31] Some call between-within models "hybrid" fixed-effects models (Allison 2009). They are related to but distinct from correlated random-effects models (*see* Schunck 2013).

[32] The estimation results I report below were substantively the same when using the alternative Amemiya-MaCurdy estimator.

disclosure requirement in place and no moratorium or ban, Texas (2015 & 2016), had the least stringent requirement (stringency=0.27), while Idaho's requirement (2015 & 2016) was the most stringent (stringency=1.66). The most liberal legislature during the study period was Massachusetts (2009 & 2010) (ideology=92.45), and the most conservative was South Carolina's (2013-2015) (ideology=0). Perhaps not surprisingly, Texas (2014) led with $26.6 million in political contributions from the oil and gas industry. In fact, Texas and California dominated in this category, with each occupying four of the top ten overall state-year amounts and averaging $16.6 million and $17.1 during those four years, respectively. The minimum contribution amount recorded was in Connecticut in 2013 (contribution=$92).

Table 3.2: Descriptive Statistics

Variable		Mean	Std. Dev.	Min	Max
Disclosure stringency (DV)	overall	0	1	-0.79	1.69
	between		0.72	-0.79	1.68
	within		0.70	-1.98	2.07
Political ideology	overall	46.19	29.60	0	92.45
	between		26.51	4.71	91.84
	within		13.65	10.07	92.14
Industry influence (logged contrib. $)	overall	11.51	2.19	4.52	17.09
	between		1.35	8.59	15.20
	within		1.73	6.39	15.39
	overall	-0.14	0.65	-0.79	1.56
Peer stringency (mean stringency of PADD peers)	between		0.35	-0.79	0.67
	within		0.54	-1.38	0.80
Economic hardship (unemployment rate)	overall	6.96	2.15	2.68	13.66
	between		1.53	3.24	9.99
	within		1.52	2.98	11.21
Historical oil+gas production rank	overall	22.65	17.23	1	50
	between		17.39	1	50
	within		0	22.65	22.65
Geology (% land area over shale play)*	overall	18.08	34.47	0	153.86
	between		34.79	0	153.86
	within		0	18.08	18.08

n=384 (48 states, 8 years)

DV (2009-2016); all other variables 2008-2015 to account for lagged predictors reported in models

*Shale plays can exceed 100% in states with multiple shale plays stacked at different depths vertically. For example, Pennsylvania overlays the Devonian (Ohio), Marcellus, and Utica plays.

Regarding the peer stringency variable, states in PADD regions with no disclosure requirements across the region during a year had the lowest regional stringency score (-0.79). In 2008, this was true for all states except nine in the Lower Atlantic and Central Atlantic regions, whose regional stringency scores were higher because of the moratorium and de-facto ban in New York and North Carolina, respectively.[33] The state-year with the highest regional stringency

[33] In 2008, New York became the first state to take new legal action with respect to fracking, effectively placing a moratorium on fracking when Gov. David Paterson ordered the Department of Environmental Conservation (DEC) to review safety and environmental issues associated with fracking before the state

score was Delaware in 2012 (1.56), which is part of the Central Atlantic PADD region. This region, which lies over the Marcellus Shale and is made up of Delaware, Maryland, New Jersey, New York, and Pennsylvania, also had the highest overall average disclosure stringency among the regions during the period (0.49). This is primarily due to the fact that three of the five states in the region (NJ, NY, MD) had a temporary moratorium or ban in place during at least one of the years, resulting in those states having the maximum disclosure stringency during that year.

North Dakota in 2014 had the lowest unemployment rate (2.68%), a figure widely attributed to the fracking boom in North Dakota's Bakken Shale during the period. The highest unemployment rate during the period belonged to Michigan in 2009 (13.66%). West Virginia has the highest percentage of surface area over a shale play (153.86%). This figure exceeds 100% for West Virginia, as well as Pennsylvania and Ohio, because they sit over multiple shale plays stacked vertically at different depths underground. Pennsylvania, for example, contains the Devonian (Ohio) shale, which lies above the Marcellus, which itself lies above the Utica. Finally, Texas produced the most oil and gas historically from 1960 to 1999, while sixteen states tied for the lowest ranking, producing no oil or gas during these years.

Table 3.3 shows the pairwise correlation matrix of variables. Disclosure stringency is strongly positively correlated with the average stringency of the focal state's peer region ($\rho<.01$), the geological control measuring the percentage of state surface area over shale ($\rho<.01$), and the historical production measure ($\rho<.01$). Perhaps not surprisingly, the historical production indicator is also positively correlated with the geology ($\rho<.01$) and industry-influence indicators ($\rho<01$). Many, but not all, of the states with shale-rock geology also have fossil-fuel rich geology located at shallower depths than the shale formations, and it is not surprising that historically active fossil-fuel producers also have relatively high political contributions from the oil and gas industry. The historical production indicator is negatively correlated with liberal government ideology ($\rho<.01$), as government officials in leading oil and gas-producing states like Texas, Louisiana, and Oklahoma tend to be less liberal. Despite the correlations among some of the predictors, a check revealed no multicollinearity problems (all variance inflation factors < 2).

Table 3.3: Pairwise Correlations

		1	2	3	4	5	6	7
1	Disclosure stringency (DV)	1						
2	Political ideology	-0.096	1					
3	Industry influence	0.0636	-.068	1				
4	Peer stringency	.431**	-.284**	.025	1			
5	Economic hardship	-.123*	.129*	0.049	-.291**	1		
6	Historical production rank	.322**	-.249**	.366**	.136**	-.057	1	
7	Geology	.357**	.012	.166**	.083	-.026	.378**	1

n=384 (48 states, 8 time spells); All independent variables lagged one year
** p<.01, * p<.05 (two-tailed)

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would issue drilling permits. North Carolina, on the other hand, had a law in place from 1945 until 2012 that effectively banned fracking because it banned horizontal drilling (N.C. Gen. Stat. § 393(d) (2008)). In 2012, the legislature enacted the Clean Energy and Economic Security Act (N.C. Sess. Law 2012-143; S.B. 820), which replaced the law banning horizontal drilling with a temporary moratorium on permits for fracking. The state then issued new rules governing fracking, including chemical disclosure requirements, which became effective March 17, 2015. This officially lifted the moratorium, but subsequent court decisions had left some regulatory issues unresolved by the end of 2016.

Regulatory Convergence, Peer Influence, and Industry Capture during Hard Times

Table 3.4 presents regression results.[34] Across all models, regulatory stringency increased over time, with significant positive effects each year after 2010. Model 1, the null model, includes only the intercept. Model 2 includes only the independent variables of interest. There, the peer stringency predictor is significantly positive (β=.322, ρ<.05), an early indicator of the importance of neighbors' stringency in influencing how stringently a focal state regulates.

Table 3.4: Influences on Stringency of State Disclosure Regulations, 2009-2016

	(1) Null	(2) IVs	(3) Main effects	(4) Full
Political ideology (govt. ideology)		-0.000	0.000	0.000
		(0.004)	(0.005)	(0.005)
Industry influence (logged political contrib. $)		-0.005	-0.006	-0.006
		(0.036)	(0.037)	(0.037)
Peer stringency (avg. stringency of PADD neighbors)		0.322*	0.330*	0.334*
		(0.137)	(0.139)	(0.139)
Econ. hardship (unemployment rate)			-0.036	-0.041
			(0.073)	(0.072)
Historical oil+gas production rank			0.018**	0.017**
			(0.006)	(0.006)
Geology (% land area over shale play)			0.008**	0.008**
			(0.002)	(0.002)
Industry influence*Econ. hardship				-0.027*
				(0.012)
Constant	0.00*	-1.403*	-0.084	4.74
	(0.039)	(0.667)	(0.687)	(2.483)
Observations	384	384	384	384
Number of groups (states)	48	48	48	48
Modeling approach	FE	B-W[a]	B-W	B-W
Year FE	n/a	YES	YES	YES
Panel-Clustered SEs	NO	YES	YES	YES
Estimator	FE	FGLS	FGLS	FGLS
std. dev. of residuals within groups u_i	0.718	0.696	0.590	0.595
std. dev. of residuals between groups e_i	0.75	0.586	0.586	0.585
Intraclass correlation (rho)	0.478	0.585	0.503	0.509
R-sq between groups		0.08	0.384	0.409
R-sq within groups		0.408	0.409	0.413
R-sq overall[b]		0.242	0.396	0.411
Wald test (χ^2) whether all coefficients differ from 0		149**	425.7**	502.5**

Robust standard errors in parentheses

*p<0.05, **p<0.01, ***p<.001 (two-tailed)

[a] Between-within modeling approach. Between-group effects and year dummies not reported.

[b] R-sq overall represents the proportional reduction in the estimated total residual variance when comparing the null model with a fixed-effects estimator to the model of interest.

[34] In the interest of space, I follow convention and do not report between-group and year fixed-effect results in Tables 7 and 8. Those results are available upon request.

Model 3 includes all main effects. Of the independent variables, the average stringency of a state's peers ($\beta=.330$, $\rho<.05$) is the strongest predictor of a state's disclosure stringency the following year. The controls of state geology ($\beta=.008$, $\rho<.01$) and historical oil and gas production rank ($\beta=.018$, $\rho<.01$) are also strongly associated with increased regulatory stringency. The positive relationship between geology and regulatory stringency was expected, as states with little to no productive shale resources have little reason to impose stringent disclosure regulations aside from symbolic purposes. But states with very high potential for fracking, even if they are at increased risk of being influenced by industry or may expect the increased economic benefits fracking brings, should exhibit a higher likelihood to issue stringent disclosure regulations than states with little shale. Similarly, states with high oil and gas production historically should be expected to display more stringent regulation—at least during the early phase of innovation, as here—than states with less experience because they likely have regulatory frameworks and agencies equipped to adapt quickly to the new activity of fracking.

Regarding regional peer influence, as predicted in Hypothesis 3, the regulatory stringency of a state's neighbors, all else equal, is a positive predictor of how stringently that state will regulate this risky activity. The positive direction and significance of the peer-stringency variable remains consistent across models ($.017<\rho<.019$) even when adding the interaction term (Model 4). This is strong evidence supporting Hypothesis 3, indicating that the most important independent variable affecting chemical disclosure stringency is the stringency of a state's peers. The positive association supports an institutionalist, field-theoretic explanation for an increase in disclosure regulation stringency, as it indicates that state political officials and regulators attend to how stringently their peers regulate a risky activity when determining how stringently they will regulate the activity in their own state.[35] My own review of state archival evidence of fracking rulemaking processes supports this conclusion. For example, from 2011 to 2014, Maryland's Department of the Environment (MDE) and its Department of Natural Resources, in consultation with an expert-led commission and policy researchers at the University of Maryland, conducted a three-part study in order to issue best practices recommendations and findings for implementation and regulation of the state's hydraulic fracturing program. As part of the study, they surveyed other practices and programs, taking particular note in each part of their report as well as the MDE's Notice of Proposed Action on Regulations that they consulted with "neighboring states" regarding policies and regulatory programs (e.g., Maryland Department of the Environment 2014:3; 2015:95).

Last, Model 4 adds the interaction term to Model 3's main effects. The most important finding that emerges from this model is the significant negative effect ($\beta=-.027$, $\rho<.05$) that results when interacting economic hardship and industry influence. While main effects for these two variables were in the negative direction as hypothesized but not statistically significant, the joint effect of increased economic hardship and monetary contributions from the fossil-fuel industry results in a significant shift toward less stringent regulation. This lends support to a theoretical explanation based on regulatory capture (Hypothesis 2), as industry may be better positioned to influence regulatory stringency in states where that are in particularly dire economic straits.[36]

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[35] Figure A-3.2 of the Appendix depicts estimated linear predictions for each state at each year.

[36] I found little support for Hypothesis 1, which predicted that the more liberal a state's government ideology, the more stringently it would regulate fracking disclosure. This could be attributable to the fact

Beyond Adoption in Policy Studies

Finally, my empirical findings reveal the importance of analyzing influences on how *stringently* governments regulate as opposed to simply assessing factors affecting whether a law or regulation is enacted. Estimating random-effects complementary log-log models, I performed the discrete-time event-history analysis typically done in studies of policy adoption and diffusion. To do so, I only changed two variables: 1) the outcome, from regulatory stringency to a binary absence/presence of chemical disclosure regulation, and 2) the peer-influence predictor, from average stringency of the focal state's PADD region to the percentage of neighbors in the region that previously implemented a disclosure regulation. Table 3.5 compares the results of this alternative analysis (models labeled "Presence") and the results reported above ("Stringency").[37] Although one-to-one comparisons of these model results are not possible, the significant effects from the stringency analysis discussed above—peer influence and the industry influence-economic hardship interaction term—are much weaker in the analysis with the binary regulatory outcome. In fact, although both are in the same direction as the coefficients from the full model of the stringency analysis, neither the peer-influence coefficient nor the interaction term reach statistical significance at the 95% confidence level.

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that that many relatively liberal states did not have fracking disclosure requirements at all, particularly during earlier years of the period.

[37] I include the estimated hazard probabilities at each time interval in Figure A-3.1 of the Appendix.

Table 3.5: Influences on Regulation Presence vs. Regulation Stringency, 2009-2016

	(1)	(2)	(3)	(4)
Outcome	Presence Main Effects	Stringency Main Effects	Presence Full	Stringency Full
<u>*Independent variables*</u>				
Political ideology (govt. ideology)	0.045	0.000	0.049	0.000
	(0.075)	(0.005)	(0.100)	(0.005)
Industry influence (logged political contrib. $)	0.044	-0.006	-0.065	-0.006
	(0.282)	(0.037)	(0.503)	(0.037)
Peer influence (% PADD neighbors with regulation)	0.063		0.059	
	(0.079)		(0.088)	
Peer influence (avg. stringency of PADD neighbors)		0.330*		0.334*
		(0.139)		(0.139)
Industry influence*Economic hardship			-0.384	-0.027*
			(0.581)	(0.012)
<u>*Controls*</u>				
Economic hardship (unemployment rate)	-0.637	-0.036	-0.812	-0.041
	(1.556)	(0.073)	(1.838)	(0.072)
Historical oil+gas production rank	0.169	0.018**	0.170	0.017**
	(0.237)	(0.006)	(0.262)	(0.006)
Geology (% land area over shale play)	0.055	0.008**	0.059	0.008**
	(0.085)	(0.002)	(0.086)	(0.002)
Constant	-9.511	-0.084	18.452	4.74
	(17.435)	(0.687)	(21.051)	(2.483)
Dependent variable	Reg. presence	Reg. stringency	Reg. presence	Reg. stringency
Modeling approach	RE compl. log-log	B-W	RE compl. log-log	B-W
Observations	384	384	384	384
Number of stateid	48	48	48	48
Year (duration) fixed effects	YES	YES	YES	YES
Decomposed covariates	YES	YES	YES	YES
Panel-Clustered SEs	YES	YES	YES	YES
Estimator	ML	FGLS	ML	FGLS

Robust standard errors in parentheses; Between-group effects and duration effects not reported

** p<0.01, * p<0.05 (two-tailed)

For random-effects complementary log-log models, integration method is mean-variance adaptive Gauss-Hermite quadrature (30 quadrature points)

3.5 Discussion and Conclusion

This paper makes several contributions at the nexus of the sociology of law, political sociology, economic sociology, and organizations. It should also appeal beyond these subfields to traditional legal scholarship, political science and policy studies, and environmental studies. First, I applied sociological field theory to explain why state governments vary in how stringently they regulate the complex, risky, but potentially economically beneficial practice of hydraulic fracturing for oil and gas. I examined one of the most controversial aspects of fracking regulation—chemical disclosure—and found that the primary drivers of increased stringency of chemical disclosure regulations are a high degree of "frackable" shale rock geology, historical experience as an energy producer, and, most importantly, a distinctly social factor—regional peer influence. A state will regulate disclosure more stringently as its peers increase their own stringency. I also found a negative effect on stringency when considering the interaction of a state's poor economic well-being and its reliance on material resources from the oil and gas industry, suggesting that states are more susceptible to industry capture the more their economic health declines.

These findings can be explained by core tenets of sociological field theory: governments are attuned to the actions of similarly situated others in their field and will tend to converge toward their peers in regulatory stringency. But in times of crisis, as in my case with states facing economic hardship, stakes become amplified. It is during these times of crisis that state officials become more susceptible to capture from powerful industry actors, who offer resources that promise to boost the economy and thus stabilize officials' positions in exchange for advancing industry interests via less stringent regulation. Such a field-theoretic explanation of factors affecting regulatory stringency is a more parsimonious explanation of influences on regulation than the disparate frameworks currently employed across a variety of scholarly traditions to explain policy diffusion and regulation.

Although the peer-influence finding in this paper is robust to alternative modeling specifications and regional measures, a limitation of this study is its inability to isolate more precisely the diffusion mechanism(s) at play with this finding. Organizational sociologists and policy scholars note that diffusion can result from a number of mechanisms, including learning, competition, and isomorphism (whether due to coercive, mimetic, or normative pressures) (Dobbin et al. 2005; Berry and Berry 2014). The regional peer-influence finding suggests mimetic forces, and the significant negative finding resulting from the interaction between economic hardship and high industry influence suggests possible competitive motivations on the part of state officials attempting to stabilize their positions and boost the economy by catering to business interests for more lenient regulation. However, qualitative research on fracking regulators and their decision-making processes would bolster such explanations.

As a second major contribution, rather than ask what influences the passage of law, as is commonly done in policy adoption studies, I have answered the more interesting yet difficult question of what influences regulatory stringency. Doing so required locating and qualitatively coding the *content* of each state's regulatory disclosure components at each year. The empirical differences between the two types of analyses bolster the argument that influences on the passage of laws or adoption of regulations can be distinct from the influences on regulatory stringency. Empirical rigor and the opportunity to distinguish adoption from stringency theoretically are worth the extra effort required to find and examine the content of legal texts rather than simply model a state's propensity to adopt or implement laws.

Finally, this paper addresses the regulatory information deficit often found with highly technical, complex, and controversial issues regulated primarily by states and local governments. I have constructed a unique database of regulatory information on the controversial practice of hydraulic fracturing and have addressed a gap in the study of regulatory stringency. To my knowledge, this is the first database of fracking regulation that covers every state over time. It will be useful to the public and to state administrative officials by providing an empirical look at influences on a highly controversial economic activity. Numerous factors—lack of resources, incentives, expertise, or time, to name a few—often impede state governments, nonprofits, and industry actors from collecting and sharing reliable, comparative regulatory information on such complex issues (Wiseman 2014:36-44). Fracking regulation is one example, but there are others (e.g., climate change, health-insurance administration).

Academics should help fill this gap of regulatory information. The first task is simply to collect regulatory information across multiple states, multiple agencies within states, and over time. The importance and difficulty of this task should not be underestimated, as these are not areas of the law that are easily traceable to single sections of state statutes. Statutes are relatively easy to locate in online databases or state legislative codes and have been the primary forms of law studied by political scientists and socio-legal scholars. However, governance of state- and locally regulated technical issues is much more complex. The "law" on these issues is often pieced together from rules and regulations across multiple state agencies within a given state and in differently organized regulatory regimes across states. Studying these kinds of legal issues over time adds complexity; historical regulatory data may be unavailable in online legal databases, agencies may change, or regulations in other parts of state administrative codes may become applicable.

Perhaps because of this complexity, there is a dearth of sociological research comparing state-level or local regulations. The payoff, however, is worthwhile, as the vast majority of codified law in the US today, especially that which regulates evolving, highly technical issues like fracking, is in the form of state-level administrative codes and regulations. Sociologists and socio-legal scholars bring theoretical and methodological toolkits that allow them to go beyond the initial task of regulatory information-gathering and conduct rich empirical work on such technical matters and the influences on regulation. This study is an important step in that direction.

CHAPTER 4

DRILLING DOWN TO THE LOCAL: OIL AND GAS LEASE CONTRACTS AS ARTIFACTS OF SOCIAL INEQUALITIES

4.1. Introduction

How do social inequalities become reinforced in legal instruments? In this chapter, I draw from economic sociology, stratification, and socio-legal studies literatures to examine the effects of social inequalities and local-network ties on mineral-rights lease contract outcomes. In this way, I will argue, contracts are social artifacts (Suchman 2003), simultaneously reflective and constitutive of social relations, categories, and biases.

The explosive growth of domestic oil and gas production over the past decade has been due mostly to the rise of new technologies and well-stimulation techniques, such as hydraulic fracturing and horizontal drilling, that the oil and gas industry has applied to previously untapped, “unconventional” shale-rock formations called shale plays. This boom is not without controversy, however. While the oil and gas industry trumpets employment growth, economic development, tax revenue increases, and increased US energy security as positive outcomes of fracking, many environmental activists and local residents point to the environmental risks, infrastructure strains, and overdependence on fossil fuels that increased fracking activity brings.

That rapid energy resource development can strain local communities and have deleterious social, political, and economic impacts has been documented in a rich literature on “boomtown” effects (Gilmore 1976; England and Albrecht 1984; Freudenberg and Gramling 1992). Empirical studies have begun to emerge documenting the economic, environmental, and social impacts of fracking (e.g., Brasier et al. 2011; Davis 2012; Weber 2012; Ladd 2013; Malin 2014; Crowe et al. 2015; Vasi et al. 2015; Johnston et al. 2016; *see generally* Jacquet, Kay, and Ramsey 2013; Jacquet 2014; Hefley and Wang 2015). However, despite hundreds of thousands of mineral-rights lease negotiations that have occurred during the recent fracking boom across the US and the centrality of leases to the overall structure of oil and gas development, there is virtually no social-science research into this process. And despite a growing recognition of their importance for understanding the sociological impacts of fracking (Bugden et al. 2016), sociologists have yet to adequately theorize or conduct systematic empirical studies of this socioeconomic phenomenon.

Anecdotal or limited qualitative evidence suggests that mineral-rights owners (grantors) with relatively few social and economic resources receive less favorable lease terms compared to others in the area (Brasier et al. 2011; Kelsey et al. 2012), that they can feel pressured and sometimes even betrayed by powerful corporate oil and gas firms with whom they enter into lease agreements (Malin and DeMaster 2016), and that those in poor and minority areas receive lower payouts than those in more privileged areas (Jerolmack 2014). Such studies, however, lack systematic data on these lease agreements and the social context surrounding contract negotiations. They also do not focus specifically on questions of how leases are valued or whether preexisting social categories factor into lease outcomes. And, understandably due to the lack of systematic data availability, to the extent that they draw any inferences about the effects of race or other individual-level characteristics on lease outcomes, they tend suffer from the ecological fallacy of imputing higher-order effects onto more micro-level processes (see Crowder and Downey 2010). Using a proprietary database of nearly 90,000 fracking mineral-rights leases from 2006 to 2010, I examine how social characteristics of individual mineral owners, such as local-community embeddedness and race/ethnicity, affect variations in bargaining outcomes (production royalty rates), net of the purely economic and geological factors commonly assumed to be the sole drivers of such outcomes. Specifically, I ask the following research questions:

1) Do grantors who also reside in the local community receive favorable lease contract

outcomes compared to those who reside outside of the local community?

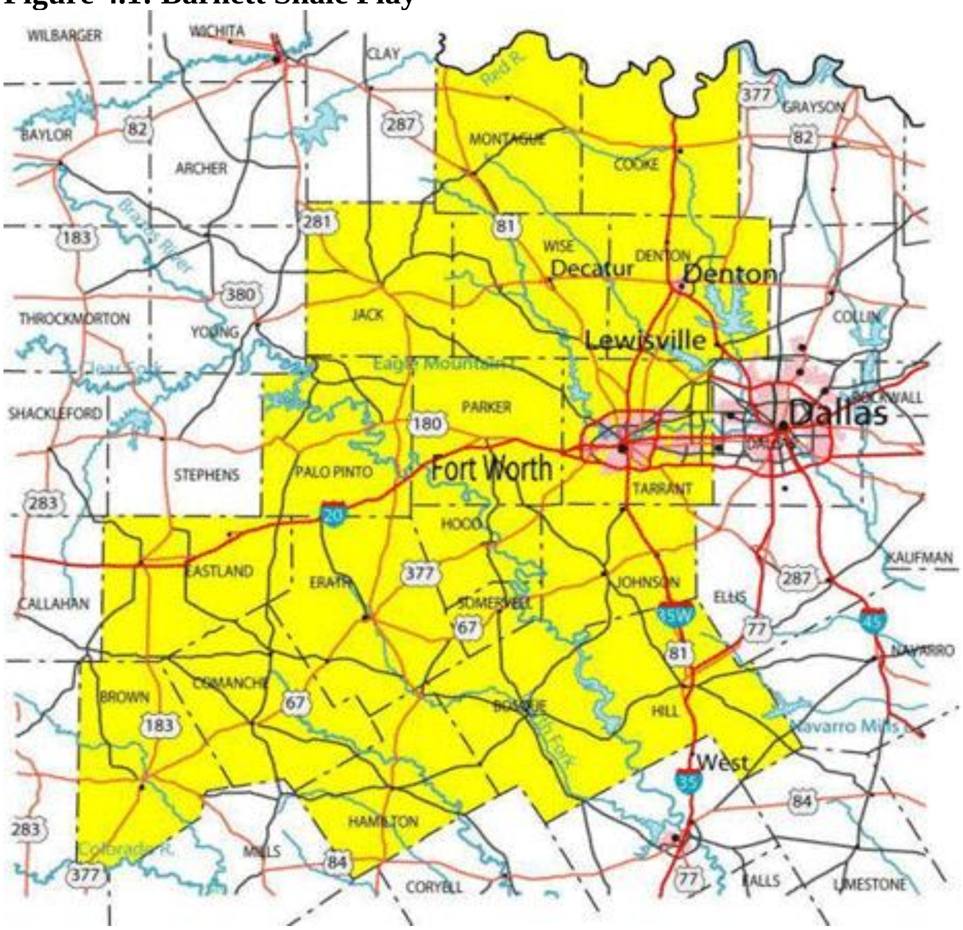
2) Are leasing contract outcomes less favorable to racial-minority grantors compared to white grantors?

The chapter proceeds as follows. First, I situate the study by discussing how mineral-rights lease markets are structured in the United States, with particular emphasis on the shale-gas hotbed of the Barnett shale play near Dallas, Texas. I describe how mineral-rights holders and firms negotiate leases, and I contextualize fracking leases by noting the economic impact fracking on local communities. I then build off of sociological theories of markets and inequality to generate hypotheses regarding the social factors that influence variations in royalty outcomes. Next, I describe the methods and analytical strategy for the empirical analysis, followed by a discussion of results. I conclude with implications for theory and suggestions for future research.

4.2 Background

As discussed in the dissertation's introductory chapter, commercially viable fracking operations developed first in Texas during the early 2000s before spreading to other shale plays around the United States (refer to Figure 1.4 in Chapter 1 for a map of shale plays and basins). The epicenter of the early fracking boom was the Barnett shale play, a shale formation rich in natural gas that is situated beneath and around the major metropolitan area of Forth Worth, Texas. Figure 4.1 depicts the Barnett shale play and its surrounding environment. In this chapter, I analyze leases between individual mineral-estate owners and oil and gas companies within the Barnett shale.

Figure 4.1: Barnett Shale Play



Source: Petrocasa Energy. 2017. "Barnett Shale Coverage Map." Accessed December 1, 2017. (http://petrocasa.com/petrocasa/barnett-shale.php).

The United States' property-rights system is unusual compared to those of other advanced nations in that the vast majority of mineral-rights owners are private individuals rather than government entities (Fitzgerald and Rucker 2014). Moreover, in the US, depending on the local property-rights regime and the ownership history of a given tract, subsurface mineral-rights owner(s) may or may not be the same as surface owners of the land above the mineral estate. Most surface tracts over oil and gas deposits in the US fall under such a split-estate legal framework.

To obtain the right to produce oil or gas from a subsurface mineral estate, a lessee-firm usually negotiates an oil and gas lease with a mineral-rights owner. Courts typically treat oil and gas lease leases as part conveyance—the mineral owner transfers rights to the minerals to another person or entity—and part lease—the lessee-firm takes on the working interest in the mineral estate in exchange for something of value and subject to certain conditions and obligations (Lowe 2009:172).[38] The owner of the working interest is responsible for operation of the the mineral-estate property and payment of drilling, well-completion, and well-operation costs on the lease. The royalty interest, specifically a production royalty, is a percentage of the production value of oil or gas produced from the mineral estate and paid to the mineral-rights owner (the grantor). Under the typical lease agreement, the lessee agrees to pay the grantor the specified royalty, usually at monthly or annual intervals, if and when it begins producing from the leased tract.[39]

The enormous growth in production has resulted in huge increases in royalty income from mineral-rights leases. In 2014 alone, production in the six major US shale regions generated an estimated $213 billion in oil and gas revenues to industry and $39 billion in royalty payments to private grantors in these areas (Brown et al. 2016). Not all private mineral-rights owners decide to lease their rights to drilling companies, of course. However, those who do enter into a lease agreement can have wide variation in their lease terms. The royalty rate one is one of the core terms of any lease and, while it generally falls somewhere between 12.5% and 33%, it is negotiable among the parties to the contract. The economic impact of leasing and variation in royalties calls for a rigorous examination of potential social stratification across lease outcomes.

4.3 Theory Development

I investigate the extent to which social factors influence variation in oil- and gas-production royalty terms paid to grantors. To evaluate such claims systematically and across locations, I draw from literatures in economic sociology, stratification, and socio-legal studies. To add to these literatures, I situate mineral-rights contracts as "social artifacts" (Suchman 2003)—material objects produced and negotiated by actors but structured by social contexts and (potentially) constitutive of social inequalities.

Although market forces and contract rules can guide mineral-rights lease negotiations, they neither determine economic relations nor do they necessarily lead to economically efficient outcomes. Instead, as sociologists and socio-legal scholars point out, economic transactions and valuations are embedded in and influenced by non-market, extra-legal social forces (e.g., networks, trust, culture, power) (Macaulay 1963; Granovetter 1985; Ellickson 1991; Fligstein

[38] Reflective of this dual nature of lease agreements, I use the terms "grantor/lessor" and "grantee/lessee" interchangeably here.

[39] Although the royalty interest is typically not subject to the costs of production, it can be subject to a share of the gross production and oil extraction taxes and post-production costs. This point is negotiable in the lease contracting process.

2001; Edelman 2004; Fourcade 2011). In this view, markets, instead of simply being sites of rational, calculative action that is determined by the strict laws of supply and demand, are socially constructed arenas in which market participants—and the prices they produce—are driven by the network ties, values, and biases that guide action in other social domains. Broadly, sociological approaches to market transactions emphasize the role of networks, on one hand, and culture, on the other, in constituting economic value and guiding exchange.

Networks and social embeddedness

The network-based approach to embeddedness has dominated much of economic sociology since White's (1981) and Granovetter's (1985) seminal works. In this view, consumers and suppliers are enmeshed in webs of social relationships, and the structure of those relationships strongly influence the rules of exchange and prices in markets. Buyers and sellers who are familiar with one another or who operate based on close relationships can draw on familiarity and trust when carrying out their transactions, thereby facilitating exchange, limiting transaction costs, and reducing the chances cheating, bad faith, etc. Because it is not realistic to expect parties to a transaction to have perfect information, familiarity and repetition supplies those transactions with "social content that carries strong expectations of trust and abstention from opportunism" (Granovetter 1985:490). Networked relations are important for signaling and reputational purposes, as market participants and parties to a transaction consider their counterparts' reputations—as honest, as tough bargainers, as high-status, as legitimate, etc.—in their negotiations and valuations (Macaulay 1963; Baum and Oliver 1992; Podolny 1993). Network ties can also help govern exchange, as, for example, when they facilitate the flow of private information in settings where access to information may be limited, thereby reducing costs and affecting prices (Uzzi 1999; Uzzi and Lancaster 2004; Bidwell and Fernandez-Mateo 2010).

Access to information is especially relevant in the context of fracking and mineral-rights leasing, as it is widely understood by local landowners and landmen (the oil and gas industry representatives most often negotiating leases) in these highly competitive markets that knowing on-the-ground information about the lease process—what other firms are paying, what neighbors are getting, and how negotiations are being carried out—is crucial in the leasing process. In other words, lease negotiations in fracking towns are inherently local dynamics, with parties on both sides of the lease transaction (grantors/sellers and firms/buyers) relying on local ties to the community to further their interests. For example, when I asked a landman informant how oil and gas firms and mineral-rights owners come to know one another, he explained a typical process thusly:

> They may have heard of you 'cause you lease their neighbor and they're like, 'Yeah, I was waiting for you to call me.' And these towns, you know, it's like, 'Do you know so and so?' 'Yeah, she works at the Dairy Queen down the street.' All right. Well, you go in there and start talking.'
> (Interview with Landman Informant 2, January 22, 2016)

Local network ties can also affect lease contract outcomes in areas where fracking is taking place. Specifically, ties to the local community are important sources of social capital for the contracting parties (see Coleman 1988), which they can then convert into economic capital in their lease agreements (Bourdieu 1986). An example is the formation of landowner coalitions in fracking-heavy areas. Such coalitions allow local mineral-rights holders to share information and, sometimes, even collectively bargain their lease terms with oil and gas firms looking to lease acreage in the area (Jacquet and Stedman 2011). More generally, in the United States, because mineral-rights estates can be severed from the surface estate, mineral-rights owners who live on the land over their minerals, or at least in the surrounding community, should be more likely to take advantage of these local-network opportunities and negotiate more favorable terms on their leases than those who own local mineral rights but live out of town.

Hypothesis 1: Local-resident grantors should receive more favorable contract outcomes than non-local grantors, all else equal.

Culture and racial disparities in economic transactions

Networks and social ties, of course, are not the only sociological factor that influence the outcomes of economic exchanges. Culture comes into play any time individuals and groups determine economic value or, indeed, engage in economic relationships (Smith 1989; DiMaggio 1994; Zelizer 2010). Even when assigning value to intangible objects, legal and accounting professionals are influenced by culture in their calculations (Fourcade 2011).

Race, as a social category, is a fundamentally cultural institution in that it is imbued with meaning and triggers biases based on one's ascriptive characteristics. We know that underrepresented racial groups experience disadvantages and disparities in almost every institutional domain (Massey 2007), including environmental pollution, housing markets, consumer credit, labor markets, etc. (see Riach and Rich 2002; Brulle and Pellow 2006; Lobao et al. 2007; Pager and Shepherd 2008; Reskin 2012). In the context of bargaining, in particular, racial minorities have been shown to receive unfavorable treatment when acting as buyers or sellers. For example, Ayres (1991) and Ayres and Siegelman (1995) conducted paired audit studies of car sales, finding that dealers quoted their white male testers significantly lower prices than black male and black female testers. On average, both black males and black females were quoted lower initial offers and received lower final offers than white males for a new car. Compared to white males, black male buyers received final offers that generated nearly $1100 more in expected profit for dealers, while final offers for black female buyers yielded about $400 more in expected profit for dealers compared to white males (Ayres and Siegelman 1995:310-311). Similarly, research shows that black sellers tend to receive worse deals in sales of consumer goods. For example, Doleac and Stein (2013) showed that black sellers of iPods receive fewer and lower offers from potential buyers when advertising an iPod for sale on an online classified website.[40]

Mineral-rights negotiations are different from the usually examined cases of consumer goods, such as automobiles, and credit-based decisions (e.g., home mortgage terms, insurance rates). My review of the sociological literature revealed no studies investigating racial disparities in contracts for property rights between private individuals and firms, as is my case of fracking mineral-rights lease contracts. However, building on what we know from past sociological scholarship in these domains, I make the following hypotheses:

Hypothesis 2a: Compared to white grantors, black grantors will receive less favorable contract outcomes, all else equal.

Hypothesis 2b: Compared to white grantors, Hispanic/Latino grantors will receive less favorable contract outcomes, all else equal.

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[40] Doleac and Stein (2013) varied the race/ethnicity of sellers by depicting a black vs. white hand in the photo advertising the good for sale.

4.4 Methods and Analytical Strategy

Study design

I obtained mineral-rights lease data from Lease Data (LD), a private data provider and analytics firm based in Texas and servicing the national oil and gas production industry.[41] Its various proprietary databases contain millions of records covering all aspects of fossil-fuel development, including production, permitting, well-log, and leasing data. LD regularly collects and digitizes mineral-rights leases from county courthouses and state agency records wherever oil and gas leasing activity is occurring.

Because leased tracts are clustered within local social spaces, this study involves hierarchical data, meaning that leases should be tied to the higher-order geographies in which they are embedded. Each lease observation contains a legal description and land-survey information for the tract that the mineral-rights lease covers.[42] I leveraged that information to obtain latitude and longitude point coordinates for the centroid of each leased tract.[43] I then performed a spatial overlay of the lease-observation point file and block-level 2010 Census Bureau's Tiger/Line Shapefiles (US Census Bureau 2010). This allowed me to match each observation's point coordinates to its corresponding 15-digit Census Block FIPS code. Because state, county, Census-tract, and Census block group FIPS codes are included within this 15-digit number, I then assigned a FIPS number for each of these geographies to every lease observation in my dataset. This was a crucial step in developing measures of my primary independent variables, which I describe later in the chapter.

Sample

The primary unit of analysis is the mineral-rights lease. The LD mineral-rights instrument database includes the type of instrument, dates and locations on/at which the instrument is recorded, the size and legal description of the leased tract, grantor and grantee names, lease terms (e.g., royalty, length of primary lease term), and many other lease-specific variables for oil and gas leases recorded from 2002 to the present.

For this chapter, I first collected private mineral-rights leases for parcels located across the United States. I bound the sample temporally by analyzing only leases that were signed by

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[41] I identify this data provider with a pseudonym. I acquired a license from LD to use its system and data.

[42] The LD database locates lease instruments only as accurately as the legal description on the lease—abstract number for leases in Texas or section/township/range descriptor in states using the Public Land Survey System (PLSS) land-grid system. It does not locate instruments specifically by their metes and bounds descriptions, which take into account physical features of the local geography, directions, and distances, to describe the boundaries of the land above the mineral estate. The database is therefore designed based on a leased tract, as identified in the abstract or survey information within the instrument. In this respect, the data are limited in two ways. First, if there are multiple abstract or survey locations described in the instrument, the database only records one observation based on the first abstract/location listed in the instrument. Second, in a situation in which multiple leases are taken simultaneously on the exact same tract (as described in the abstract or survey) during the same data-collection period (varies by county, but roughly every one to three months), the database records only the first lease collected during that data-collection period.

[43] To assign latitude/longitude coordinates to each lease observation, the coordinates are positioned at the centroid of the area identified by abstract/survey to which the lease is tied. In most cases, this a reasonably accurate proxy for the actual latitude and longitude of the lease. In a few cases, this may be less precise (e.g., in South Texas, Spanish land-grant portions that can be over ten miles long and several miles wide).

the contracting parties and recorded at the appropriate county or local government agency between January 1, 2006 and December 31, 2010. Those dates fell squarely within the fracking boom and well before production began declining because of falling energy prices around 2014. Additionally, my commercial data provider, while providing coverage for leases recorded in major oil and gas-producing counties back to 2002, provides full coverage for leases recorded in all counties beginning in 2006, so collecting 2006-2010 leases avoids coverage problems present before 2006. Finally, sampling on this period allows me to match the lease data to 2006-2010 five-year estimates for block groups from the Census Bureau's American Community Survey (ACS) (US Census Bureau 2016).

I narrowed the universe of possible observations for the sample as follows. First, the data comprise only lease contracts (not memoranda of leases, extensions, amendments, seismic options, etc.) because only these instruments systematically include full data for royalty rate, primary lease terms, and other critical location- and lease-specific information. I analyze only privately negotiated leases entered into by individual mineral-rights grantors; I do not consider leases with the federal government or a state government as grantor because most of those leases' royalty rates are obtained via auction instead of private negotiation and because governments lack the social characteristics (e.g., local residency; race) of interest here. I also excluded any observations with missing latitude or longitude coordinates. Missing point coordinates were due to missing or corrupted data entered from the land-grid abstract or survey information within the lease. Excluding these observations was reasonable because point coordinates are key to matching the lease observations to location-based geological data. In addition, I did not consider contracts listing zero months or missing data for the length of the primary lease term. I made this decision because the lease's primary term is a fundamental primary clause in any lease and because I use it as a predictor in my models. Finally, I dropped an additional 3,776 observations with missing data for royalty rate. This resulted in a preliminary dataset of 1,405,909 observations across the United States.

I further limited that data by dropping observations satisfying each of several other conditions. First, I excluded any leases whose grantors were determined to be organizations (n=256,941) or missing (n missing=291) by my named-entity-recognition algorithm (detailed in the discussion of independent variables below), as opposed to an individual person (n=1,148,677). Next, I dropped any lease with a grantor address that I either could not geocode at all or only to a point-level of precision. In other words, I kept leases where the geocoder returned a point address or street address (n=820,891) and dropped those where geocoding failed or else the geocoded address only resulted in precision at the level of, for example, a street name, ZIP code, or locality (n=327,786). This was necessary because I matched grantor names and addresses to Census block data in order to predict their race/ethnicity; matching Census data to levels of geography potentially broader than blocks themselves would lead to inaccurate conclusions. Finally, I dropped the few remaining outliers with royalties less than 2% (n=129) or greater than 50% (n=72). This resulted in a nationwide sample of 796,678 observed leases across 7,421 block groups in which the leased area is located. Grantors within this set of leases reside in 2,861 counties and all 50 states plus Washington, DC.

However, the two analytic samples on which I estimate models in this chapter consist of only those observations with full coverage on all covariates in the models. Because I only kept observations for which I could predict a race/ethnicity with 90% confidence, my measure of grantor's race had the most missing data among model covariates (n missing=255,506). The other main contributor of missing data was the natural-gas futures price variable (n missing=82,641), primarily because some leases were signed on weekends or holidays and thus had no corresponding match to the daily market price. After accounting for missing data across any covariate of interest, the analytic sample for the regression analysis of all possible cases in the United States, which I report in Table 4.6 later in the paper, was 483,883 leases. Accounting for the clustering of lease locations within neighborhoods (Census block groups), this nationwide sample of leases is located within 6,894 clusters.

The sample on which I focus most of the chapter is further reduced to only leases located within Texas's Barnett shale play. This was strategic for several reasons. First, limiting the sample to one shale play controls for much of the geological, legal, and economic variation that would otherwise be impossible to account for had I included cases from around the country. Second, given my observation period of 2006 to 2010, the Barnett was highly active during this period but not just coming online, allowing me to maximize potential variation in lease payouts. Third, as I described above, the Barnett was the first region to experience a drilling boom. And because of its suburban location near Dallas and Fort Worth, it has a more diverse pool of potential lessors than other, more rural shale areas in the country. After geocoding the leases and performing a spatial intersection with the EIA's shale-play data (US EIA 2016b), the Barnett sample I analyze contains 88,292 lease observations with full coverage on all variables. These leases are clustered within 1,119 block group areas and 36 counties.

Table 4.1 lists variable names, the level at which each is measured (1=lease-level), and descriptions. Below, I describe the variables in more detail.

Table 4.1: Variable names and descriptions

Variable Name	Level	Description
Dep. Var.		
royalty	1	royalty % to grantor (lease-level royalty)
Indep. Vars.		
local grantor	1	dummy indicating whether grantor resides in same county as center of leased area
gantor race	1	predicted race of grantor (1=whi;2=bla;3=his;4=other)
Controls		
leased area	1	area of leased parcel in acres
primary term	1	length of primary lease term in months
gas price	1	3-month NYMEX nat. gas futures price on lease date
lease date	1	date of lease agreement (in days; from 1/1/06 to 12/31/10)

Notes: Level 1=lease-level; Level 2=Census block group in which lease centroid is located

Dependent variable

Royalty. The dependent variable is the lease royalty. The royalty is the fraction of a well's production income paid to the grantor based on the contribution of the grantor's acreage on the lease to the producing well. To obtain a royalty percentage ranging from 0 to 100, I multiplied the royalty rate by 100. The higher the royalty, the greater the percentage of production income the individual grantor will receive from oil or gas production on his or her mineral estate.

Independent variables

Out-of-town vs. local grantors. First, to assess the effect of local-community embeddedness on lease payouts, I include a measure indicating whether the mineral-rights grantor is an out-of-town or local resident. In split (or severed) estates, common in the US, the subsurface mineral-rights owner(s) differs from the surface owner of the land above the mineral estate. Although data limitations prevent me from accurately identifying split-estate leases, I was able to measure whether a lease's mineral-rights owner (the grantor) resides in close proximity to the leased area. Using GIS software to match grantor-address locations and leased-tract centroids to their respective counties, I assigned a residency indicator to denote when the grantor's address is located outside the county in which the mineral estate is located (x=0) and when the grantor resides within the same county (x=1).

<u>Grantor's race/ethnicity.</u> Because race/ethnicity is the second primary independent variable of interest, one would ideally want to know the individual grantor's race. Considering obvious data limitations in obtaining each individual grantor's true race/ethnicity, I followed established procedures to infer grantor race based on each grantor's surname and address on the lease proxy. To do this, I first used natural-language processing tools to parse, label, and standardize grantor addresses and grantor names into formats suitable for further analysis.[44] Next, I used geocoding tools from ArcGIS, a Geographic Information Systems (GIS) software package, to obtain the point coordinates (longitude and latitude) corresponding to each grantor's address. I then matched each address to its 15-digit Federal Information Processing Standards (FIPS) code at the Census block level.

Last, I implemented Imai and Khanna's (2016) algorithm to infer each grantor's race based on the combination of his/her surname and the Census block within which the grantor's address is located. For each observation, the algorithm returns the predicted probability that the surname-Census block combination has a race/ethnicity of White, Black, Hispanic, Asian, or Other. Due to the low number of observations the categories of Asian and Other, I collapsed into one single category, resulting in a four-category measure. The probabilities are cumulative across these groups. For example, a hypothetical person's predicted probability for White could be 0.75, 0.15 for Black, 0.05 for Hispanic, and 0.05 for Other. In analyses below, I only include observations where the predicted grantor's race meets or exceeds an accuracy threshold of 90%.

Controls

<u>Leased area.</u> To control for the size of the leased parcel, I measure the leased parcel in number of acres. I obtained the variable directly from the number of acres identified in the lease instrument. The goal of oil and gas firms when purchasing leases is to gain control of as much contiguous mineral acreage in a producing play as possible. Larger tracts are more valuable because they require producers to negotiate with few separate mineral owners in a given area and allow them more freedom to develop an area without worry that they are intruding on another owner's or competitor's property. I therefore expect larger leased areas to command higher royalty rates.

<u>Primary lease term</u>. I also control for the length of the primary lease term, as measured in number of months. The primary lease term is the maximum period that the lease will be in effect

[44] For addresses, I relied primarily on the "usaddress" Python library. This library allows one to make and improve probabilistic parsers that use conditional random fields to label address components and, ultimately, make informed guesses about the structure of unstructured texts (see https://github.com/datamade/usaddress). To parse grantor names and perform named-entity recognition (e.g., categorize a name as person vs. organization), I used similar tools from the "probablepeople" Python library (https://github.com/datamade/probablepeople) and Python's popular Natural Language Toolkit (NLTK) package for natural-language processing, combined with regular expressions.

without drilling on the leased property.[45] Firms tend to wait until just before the expiration of the primary term to begin drilling. As with instrument area, I collected data for this variable from the lease contract itself. A longer primary lease term gives the lessee drilling company a longer amount of time to possess the mineral rights without having to begin production and thereby incur operating costs, including the commencement of royalty payments. A longer primary term may also signal less confidence in the leased estate's production potential; otherwise, firms would have less incentive to seek a lengthier term before realizing revenue. I thus expect a negative relationship between the length of primary lease term and royalty to the grantor, independent of any main effects.[46]

<u>Economic market forces: commodity futures prices</u>. According to standard accounts from the industry, the main factors that influence potential profitability of a leased tract (and as a consequence, the royalty rate) are economic and rational in nature. Broadly, profitability may be influenced by the amount and type of oil and gas in place, the costs imposed by technology and the geology housing the oil or gas, and market forces of supply and demand. This hyper-rational, reductionist approach to assessing lease values should not be surprising, as we know from economic sociology that firms in emerging, competitive markets characterized by uncertain outcomes will work to develop common scripts and cognitive approaches to pattern a stable social world that then facilitates market exchange (Fligstein 2001; Beckert 2009). The more rational, 'objective,' and accessible the approach, the better (MacKenzie and Millo 2003; Meyer and Rowan 1977).

Because I am most interested in how the more decidedly *social* factors associated with the seller in this lease transaction (e.g., grantor's community ties, sociodemographic characteristics of grantors) also influence contract outcomes, it is crucial that I include careful measures of such economic factors in my models. Of these three economic factors, I control for the first two by limiting my analysis to leased areas that fall within one shale-play region: the Barnett shale. Shale plays are categorized by the geological features common within them (source-rock lithology, age, etc.), so analyzing only contracts for areas contained within one shale play controls for many of these economic factors.

To control for market forces of supply and demand, I include a measure of the 36-month commodity futures price of natural gas that corresponds to the date the parties signed the lease. I use the New York Mercantile Exchange's (NYMEX) 36-month commodity futures prices instead of spot prices for natural gas on the date of signing because, as explained above, firms negotiate mineral-rights leases with any eye toward realizing profits from a producing well at some point in the future, which is often many months later, if at all. I choose 36 months from signing as the time period because it is the modal number of months for the primary lease term (i.e., the time granted to the firm before it must start producing) in the dataset, as well as the industry. I use the natural-gas futures price in this analysis because fracking for natural gas, not

[45] The primary term can be extended by a separate lease extension agreement. Once oil or gas production starts on the leased parcel, the secondary lease term begins and continues in effect until production ceases.
[46] Along with primary lease term and royalty, the lease bonus payment—whether in the form of a per-acre dollar amount or a bonus received by the grantor—is another "primary" clause of a standard oil and gas lease contract. If the lessee pays the grantor a bonus, it is not tied to future production (as the royalty is) and is usually made at the time the lease is executed. As a consequence, and to avoid revealing their willingness to pay to competitor firms in the area, such a payment is usually not recorded on the lease instrument. Because of this, data on lease bonus payments are extremely limited in my database. I therefore cannot include it as a control in my models.

crude oil, dominates production in the Barnett shale region. All else equal, I expect a positive correlation between futures price and royalty rate, as higher prices signal a bullish market for future production.

Time. Finally, I control for time in the models by including a variable that measures the number of days since January 1, 2006 until date of the lease agreement. This measure can range from 0 to 1825, which correspond to the first and last possible dates of the observation period: January 1, 2006 to December 31, 2010.

Analytical strategy

I estimate a multilevel, random-intercept model. This model accounts for the unrealistic assumption from the basic multivariate linear regression model that the estimated residuals of royalties of leases for areas located within the same geographic area (Census block group) are uncorrelated given the observed covariates. A likelihood-ratio test of the null (i.e., unconditional) model without the random intercept (i.e., conventional OLS regression) compared to the model with the random intercept and no predictors confirms that including a random intercept is preferred (likelihood-ratio chi-squared=61354.17, p<.001). The decision to cluster leases within Census block groups was strategic for theoretical reasons, as well. First, it stands to reason that the clustering effects of local areas in this case of lease negotiation outcomes, where economic and geological factors are key, would be most influential at the shale-play geographic level, which I control for as much as possible by analyzing only leases within the Barnett shale play.[47] But next in order of expected influence in my case, where I expect local-community ties and social biases to play a role, should be social groupings, particularly lower-order geographic levels, like local communities and neighborhoods (as opposed to higher-order levels, such as counties and states). By this logic, clustering within the most micro-level geography for which sociodemographic data are available—Census blocks—would be ideal, but the block group level is the most specific level of geography for which the Census's ACS provides five-year 2006-2010 multiyear estimates, which match my observation period.[48]

This random-intercept model is represented by Equation 1,

$$\begin{aligned} logroyalty_{ij} = \beta_0 + \beta_1 grantorlocal_{ij} + \beta_2 grantorblack_{ij} + \beta_3 grantorhispanic_{ij} \\ + \beta_4 grantorother_{ij} + \beta_5 leasearea_{ij} + \beta_6 primterm_{ij} + \beta_7 gasprice_{ij} \\ + \beta_8 leasedate_{ij} + \zeta_j + \epsilon_{ij} \\ \zeta_j | x_{ij} \sim N(0, \psi) \\ \epsilon_{ij} | x_{ij}, \zeta_j \sim N(0, \theta) \end{aligned} \tag{1}$$

where ζ_j is the cluster-level error term, ϵ_{ij} is the unit-level error term, ψ is the between-cluster variance, and θ is the within-cluster variance. This random-intercept model thus allows for the intercept to vary between clusters and splits the total error into two error components. Here, ζ_j

[47] Even within a shale play, some geographic areas may have more gas-production potential than others, so adding the more-specific block group-level geographic clustering aids the analysis in this sense, as well.

[48] And from a practical standpoint, because oil and gas leases are often located in rural areas, ACS five-year block group estimates are more statistically reliable for less populated areas and small-population subgroups (e.g., some racial-minority subgroups in given rural areas), as block groups do not need to meet a population threshold for five-year estimates, unlike one-year and three-year estimates.

and ϵ_{ij} are assumed to be independent over clusters j, independent of observations x_{ij}, and independent of each other. In addition, the unit-level error term ϵ_{ij} is assumed independent over units i. However, to adjust for the lack of independence of observations within clusters, I report cluster-robust standard errors in all models, which are based on the Huber/White/sandwich estimate of the variance (Huber 1967; White 1980) but generalized to account for the clustering (Froot 1989; Williams 2000).

4.5 Results

Descriptive statistics

Table 4.2 provides descriptive statistics for the variables of interest. I present both overall summary statistics across the whole sample and between-cluster statistics, which represent the means, standard deviations, minimums, and maximums of the cluster means. All predictors are measured at the lease level. The analytic sample contains 88,292 observed leases within 1,119 clusters. On average, each cluster contains 78.9 lease observations.

The dependent variable—royalty percentage—has an overall mean of 22.52 (sd=2.72), and ranges from 2 to 50. The grantors tend to reside in the same county as the leased area, as the overall mean for the binary local grantor measure of 0.859 means that 85.9% of grantors are local. The grantor race/ethnicity categories are listed in order according to how they were coded (1-4): white grantors (n=61,245; 69.4% of the sample), black grantors (n=6,603; 7.5%), Hispanic/Latino grantors (n=17,958; 20.3%), and other race/ethnicity (n=2,486; 2.8%).

The average size of a lease is 39.18 acres, although there is considerable variation (sd=239.75), with the smallest leased tract being only .002 acres and the largest being 10,419 acres.[49] The average primary lease term is 44.74 months (sd=12.77), and the average 3-month natural-gas futures price is \$7.94 (sd=\$1.97). The average lease date is 724, which corresponds to December 26, 2007. The first observed date for a lease is January 3, 2006 and the last is December 28, 2010.

Looking at the data by county, Table 4.3 shows that the majority of leases in the dataset (n=66,307) are located in Tarrant County, TX, which, if ranking counties in terms of total natural-gas gross withdrawals, moved from the 20th-largest to 2nd-largest producer of natural gas in the country over the five years from 2006 to 2010. Johnson County had the second-most leases in the dataset (n=5,994), and it was the 5th-largest producer of natural gas in the country in 2010 (USDA ERS 2016). These two counties, along with Denton County and Wise County, are considered the four "core" counties in the Barnett shale play, and are ranked first and second in the dataset in terms of number of leases. As shown in Table 4.3, three out of these four counties rank in the top-four of the dataset in terms of mean royalty rate: Tarrant, Denton, Ellis, and Johnson counties.

[49] Because leased area exhibits high positive skewness, to improve model fit, I transformed the variable by calculating the natural log and used that as the leased-area covariate in the models.

Table 4.2: Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Obs.
DV						
royalty %	overall	22.52	2.72	2	50	88292
	between	22.10	2.57	12.5	25.67	1119
	within		1.86	2.79	53.46	
IVs						
local grantor	overall	0.859	0.348	0	1	88292
	between	0.792	0.273	0	1	1119
	within		0.281	-0.137	1.792	
grantor race: White	overall	0.694	0.461	0	1	88292
	between	0.791	0.303	0	1	1119
	within		0.308	-0.302	1.678	
grantor race: Black	overall	0.075	0.263	0	1	88292
	between	0.036	0.128	0	1	1119
	within		0.183	-0.842	1.074	
grantor race: Hispanic	overall	0.203	0.403	0	1	88292
	between	0.144	0.244	0	1	1119
	within		0.305	-0.781	1.202	
grantor race: Other	overall	0.028	0.165	0	1	88292
	between	0.030	0.091	0	1	1119
	within		0.153	-0.527	1.027	
Controls						
leased area (acres)	overall	39.18	239.75	0.002	10419	88292
	between	62.69	215.42	0.04	3948.95	1119
	within		192.14	-2195.71	9937.80	
primary term (months)	overall	44.74	12.77	1	216	88292
	between	41.13	9.95	6	61.2	1119
	within		8.32	-9.66	199.54	
	overall	7.94	1.97	3.51	13.73	88292
gas price (3-month future)	between	7.99	1.32	3.98	13.53	1119
	within		1.74	-0.25	15.34	
lease date	overall	723.87	380.42	2	1822	88292
	between	725.05	271.11	8	1736.11	1119
	within		317.78	-599.03	2308.40	

Between-cluster statistics report mean, std. dev., min, and max of cluster means.

Within-cluster std. dev. represents std. dev. from cluster mean. Min and max reports min and max deviations from cluster mean, respectively.

Average of 78.9 lease observations within cluster.

All leases in sample executed and recorded between 01/01/2006 and 12/31/2010.

Untransformed measure of leased area reported here. Natural-log transformation used in models.

Table 4.3: Royalty Statistics by County, Barnett Shale

County	N	mean	sd	median	min	max
Archer	149	18.7	2.15	18.8	12.5	22
Bell	9	18	3	20	14	20
Bosque	37	20.2	1.28	20	18.8	25
Callahan	193	17.7	2.52	18.8	8.33	25
Clay	487	19.4	3.19	20	12.5	50
Comanche	44	16	2.82	16.2	12.5	20
Concho	20	18.9	0.926	18.8	16.7	20
Cooke	92	19.7	2.78	20	12.5	25
Coryell	24	13.2	1.87	12.5	12.5	20
Dallas	4417	21.3	2.69	20	12.5	25
Denton	1217	22.9	2.67	23	12.5	27
Eastland	111	16.7	2.81	16.7	12.5	25
Ellis	100	22.4	3.67	25	12.5	25
Erath	565	20	1.64	20	10	25
Hamilton	49	19.6	0.871	20	16.7	20
Haskell	26	17.1	1.96	17.7	12.5	18.8
Hill	343	20.2	2.05	20	10	25
Hood	737	20.1	2.15	20	11	25
Jack	564	19.7	2.57	20	12.5	25
Johnson	5994	21.9	2.46	22	10	33
Knox	16	15.6	2.9	16.8	12.5	18.8
Mclennan	102	14.4	3.13	12.5	12.5	20
Montague	2560	19.2	2.51	20	3.13	25
Palo Pinto	306	19.3	2.37	20	12.5	25
Parker	2115	20.8	2.32	20	10	50
Runnels	190	17	2.83	18.8	6.25	20
Shackelford	104	19.3	1.37	20	12.5	25
Somervell	180	19.7	1.81	20	12.5	25
Stephens	338	18.8	1.82	18.8	12.5	25
Tarrant	66307	23.1	2.37	25	2	30
Taylor	39	17.4	3.24	18	12.5	25
Throckmorton	42	16	3.16	15.6	7.5	20
Wichita	25	19.7	1.65	20	15.6	25
Wise	656	19.2	3.18	20	3.13	25
Young	134	17.8	2.85	18.8	12.5	26
Total sample	88292	22.5	2.72	23	2	50

Finally, Table 4.4 displays the pairwise correlation matrix for the variables. The table provides an early glimpse into the positive relationship between royalty and local grantors, as the bivariate correlation here is significantly positive ($r=.205$; $p<.001$). The controls of leased area and primary lease term are negatively correlated with royalty ($p<.001$), while gas price and lease date are positively correlated with royalty ($p<.001$). Leased area exhibits a strong negative correlation with local grantor (r=-.526, p<.001), indicating that local grantors tend to lease out smaller tracts. This suggests that out-of-town grantors tend to own larger swaths of mineral rights; this could warrant additional research into axes of inequality in terms of lease holdings between local and out-of-town owners. As for the grantor-race dummies, without considering multivariate analyses, the correlation matrix shows the strongly negative bivariate relationship between Hispanic grantors and royalty (r=-.030, p<.001). The table also shows a positive correlation between royalty and grantors of “other” race/ethnicity (r=.051, p<.001) and, albeit weaker in magnitude, between royalty and black grantors (r=.010, p<.01). In the regression analyses, categories for Black, Hispanic, and Other grantors are analyzed in reference to the base category (white).

Table 4.4: Pairwise Correlations

	Variable	1	2	3	4	5	6	7	8	9	10
1	royalty	1									
2	local grantor	.205***	1								
3	race: white	.002	-.196***	1							
4	race: black	.010**	.085***	-.428***	1						
5	race: hispanic	-.030***	.159***	-.760***	-.144***	1					
6	race: other	.051***	.026***	-.256***	-.048***	-.086***	1				
7	leased area (log)	-.307***	-.526***	.304***	-.141***	-.227***	-.071***	1			
8	primary term	-.124***	.171***	-.365***	.165***	.306***	.01**	-.382***	1		
9	gas price	.143***	.102***	-.010**	-.010**	.002	.038***	-.092***	-.054***	1	
10	lease date	.344***	-.090***	.064***	-.058***	-.048***	.032***	-.032***	-.105***	-.297***	1

n=88,292 (nested within 1,119 clusters)
*** p<.001, ** p<.01, * p<.05 (two-tailed)

Regression results

Barnett Shale estimates. Table 4.5 displays regression results for the random-intercept models. These models return overall estimated effects; in other words, they assume the estimated effect is the same at the lease- and cluster-levels. Model 1 includes only the random intercept and no predictors, Model 2 adds controls, Model 3 substitutes the independent variables of interest (local-resident grantors and grantor race/ethnicity), and Model 4 includes all covariates.

Model 1 shows us that the estimated mean royalty, when taking into account the clustering, is 22.136 (se=0.075, p<.001). The estimated intra-class correlation (ICC) for this null multilevel model—called the variance-components model because it breaks down the total error into lease-level and cluster-level components—is .622 (se=.016). In other words, 62.2% of the total variance in the model is accounted for by the between-cluster variance Ψ. Turning to Model 2, the estimated effects for all controls are statistically significant at the 99% confidence level and in the expected direction. The higher the gas-futures price at the time of signing, the larger the leased area, and the later in time the lease agreement is made, the higher the expected royalty, all else equal. Leases with longer primary lease terms yield an expected negative effect on royalty, net of the other factors.

The results for Model 3 show that, without including any of the controls, the estimated effect on the royalty percentage of going from a non-local grantor to a local grantor is not statistically significant, all else equal. However, the estimated effect of changing from a white grantor to a black grantor results in an increase in estimated decrease of .565 percentage points (β=-.040, se=.163, p<.001). The effect for Hispanic grantors is similarly negative, indicating that a change from a white to Hispanic grantor results in an estimated decrease of .318 percentage points in royalty (β=-.318, se=.053, p<.001).

More important, however, are the results once I add the controls in Model 4. First, as indicated in Table 4.5, the estimated intra-class correlation for the full model is .687 (se=.015), meaning that 68.7% of the total variance in the model is accounted for by the clustering. Second, the direction and magnitude of the estimated effects for all controls from Model 2 hold once the independent variables are included. Only the positive effect for leased area (β=.121, se=.020, p<.001) increases in any appreciable way compared to its estimate in Model 2

Table 4.5: Influences on Lease Royalties (Barnett Shale, TX), 2006-2010

	(1) null	(2) controls	(3) IVs only	(4) full
IVs				
local grantor: Yes			-0.069	0.233***
			(0.056)	(0.053)
grantor race: Black			-0.565***	-0.287
			(0.163)	(0.154)
grantor race: Hispanic			-0.318***	-0.210***
			(0.053)	(0.042)
grantor race: Other			-0.070	-0.056
			(0.057)	(0.045)
Controls				
leased area (logged acres)		0.114***		0.121***
		(0.019)		(0.020)
primary term (months)		-0.030***		-0.030***
		(0.005)		(0.005)
gas futures price		0.215***		0.215***
		(0.014)		(0.014)
lease date		0.003***		0.003***
		(0.000)		(0.000)
Constant	22.136***	19.707***	22.26***	19.531***
	(0.075)	(0.305)	(.088)	(0.307)
est. between-clust resid. variance[a]	5.787	6.132	5.896	6.088
	(0.301)	(.348)	(.307)	(.185)
est. within-clust resid. variance[b]	3.51	2.779	3.494	2.771
	(0.137)	(.118)	(.137)	(.092)
Observations	88,292	88,292	88,292	88,292
Number of groups	1,119	1,119	1,119	1,119
Est. method	MLE	MLE	MLE	MLE
Varying intercept	YES	YES	YES	YES
Residual-error structure	independent	independent	independent	independent
Cluster robust SEs	YES	YES	YES	YES
n parameters	3	7	9	13
model deg. of freedom	0	4	4	8
log-likelihood	-182842.47	-172683.55	-182661.05	-172560.94
chi-squared (Wald)		527.06***	47.39***	667.99***
intra-class correlation (ICC)	.622	.688	.628	.687
ICC std error	.016	.015	.016	.015

Robust standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

Level 1 = Lease; Level 2 = Leased area Census block group

[a]For uncond. model, est. between-cluster variance; [b]For uncond. model, est. within-cluster variance

As for the independent variables of primary interest, Model 4 indicates that the local residency and Hispanic/Latino race covariates yield the strongest expected effects. Here, the local grantor covariate is now significantly positive (β=.233, se=.053, p<.001), indicating that, once I control for economic factors, a grantor who resides in the same county as the leased location can be expected to receive a royalty increase of .233 compared to a non-local grantor, all else equal. As for grantor's race, the strongly significant expected negative effect for black grantors (compared to whites) goes away once controls are added. However, although the size of the coefficient is reduced from the model without controls, the expected negative effect on Hispanic/Latino grantor remains highly significant (β=-.210, se=.042, p<.001).

The results from the full model thus provide strong empirical support for the hypothesis that community embeddedness (Hypothesis 1) will boost local grantors' contracted-for royalty rates. They provide mixed support for Hypothesis 2. Once I controlled for economic factors, the hypothesized negative relationship between Black grantors and royalty outcome (Hypothesis 2a), although negative, was not strong enough to confidently reject the null hypothesis of no relationship. However, the hypothesized negative effect of being an Hispanic grantor (Hypothesis 2b) remained strong even when adding controls to the models. This suggests that, at least for the area around Texas's Barnett shale, Hispanics experienced more disparities in their contracts that other racial groups. This finding, taken together with the weaker result for other non-white grantors, suggests that future research would benefit by investigating whether one's primary language (English vs. non-English) plays a role in lease negotiations—perhaps due to information asymmetries exacerbated by a language barrier—independent of any racial effects.

Nation-wide estimates. Finally, although I cannot say that my results are necessarily generalizable to the rest of the country, I estimated the same models on the sample of leases across the entire United States. Table 4.6 displays the results. They support my findings regarding the negative effects for Hispanic/Latino grantors in the Barnett shale play (compare Tables 13 and 14). In fact, when estimating the models on this sample, which contained 483,883 leases nested within 6,894 clusters, not only does the change from being white to Hispanic grantors result in an estimated .208 decrease in royalty percentage, (β=-.208, se=.041, p<.001), but, unlike in the models for the Barnett shale area in Texas, the effect of being black (compared to white) is also predicted to result in a .432 decrease in royalty, all else equal (β=-.432, se=.067, p<.001). This effect is even slightly larger for Blacks (z-statistic=-6.49) compared to Hispanics (z-statistic=-5.12). However, the predicted positive effect for local grantors from the Barnett shale analysis is in the same direction but not statistically significant, suggesting that perhaps the benefits conferred by local ties to the community play out differently in different parts of the country. Again, though, these results should be interpreted with caution given the likely omitted-variable bias for this sample covering such a large area, but they support my primary findings and indicate that the role of race & ethnicity in oil and gas leasing warrants further testing and investigation.

Table 4.6: Influences on Lease Royalties (USA), 2006-2010

	(5) null	(6) controls	(7) IVs only	(8) full
IVs				
local grantor: Yes			-0.011	0.021
			(0.021)	(0.019)
grantor race: Black			-0.463***	-0.432***
			(0.065)	(0.067)
grantor race: Hispanic			-0.242***	-0.208***
			(0.044)	(0.041)
grantor race: Other			-0.190	-0.022
			(0.048)	(0.043)
Controls				
leased area (logged acres)		0.015*		0.013
		(0.007)		(0.007)
primary term (months)		-0.031***		-0.031***
		(0.002)		(0.002)
gas futures price		0.072***		0.072***
		(0.009)		(0.009)
lease date		0.001***		0.001***
		(0.000)		(0.000)
Constant	18.049***	17.880	18.079***	17.892
	(0.047)	(0.145)	(.048)	(0.144)
est. between-clust resid. variance[a]	14.467	13.629	14.599	13.751
	(0.189)	(.183)	(.190)	(.185)
est. within-clust resid. variance[b]	3.677	3.421	3.671	3.416
	(0.086)	(.092)	(.086)	(.092)
Observations	483,883	483,883	483,883	483,883
Number of groups	6,894	6,894	6,894	6,894
Est. method	MLE	MLE	MLE	MLE
Varying intercept	YES	YES	YES	YES
Residual-error structure	independent	independent	independent	independent
Cluster robust SEs	YES	YES	YES	YES
n parameters	3	7	9	13
model deg. of freedom		4	4	8
log-likelihood	-1016153	-998734.35	-1015824.91	-998435
chi-squared (Wald)		708.9***	83.63***	838.83***
intra-class correlation (ICC)	.797	.799	.799	.801
ICC std error	.005	.005	.005	.005

Robust standard errors in parentheses
*** p<0.001, ** p<0.01, * p<0.05
Level 1 = Lease; Level 2 = Leased area Census block group
[a]For uncond. model, est. between-cluster variance
[b]For uncond. model, est. within-cluster variance

Robustness checks

The model results for the main Barnett shale analysis are robust to various other specifications. For example, the Appendix's Table A-4.1 displays results for "between-within" models in the Barnett shale. Such a "between-within" model, unlike the more commonly used random-intercept models I report in Tables 13 and 14, embeds a fixed-effects estimator within the framework of a random-effects mixed model (Allison 2009:23-25). In other words, it yields separate coefficients for the fixed and random parts of the equation rather than assuming the within- and between-cluster effects for each covariate are the same. Nevertheless, the results (with the exception of the between-cluster effect for local grantors) for the independent variables of interest are substantially the same even when decomposing the covariates into within (i.e., fixed) and between (i.e., random) effects.

My results are also robust to transformations of the dependent variable. For example, given that the continuous outcome royalty percentage is not uniformly distributed but instead tends to "clump" around common, boilerplate lease-contract percentages (e.g., 15%, 18.75%, 20%, 25%), I transformed the royalty outcome into a categorical variable at those thresholds, then estimated a multilevel ordered logistic regression model. The direction and significance for all predictors were substantially similar to those of the models I report here in Table 4.5, with the exception of the Black grantor race predictor, which was in the same negative direction but (barely) crossed the 95% significance level (odds-ratio=.501, $p<.05$, two-tailed).

In addition, as a sensitivity check, I changed the grouping cluster from Census block group to the broader Census-tract level (n clusters=573).[50] This resulted in no substantive changes to the findings from the main analyses reported in Table 4.5. Every estimated parameter in the full model here was in the same direction and at the same statistical significance level as its counterpart in the full model (M4) in Table 4.5, which used Census block group as the cluster variable. Of primary interest, the estimated positive effect for local grantor was slightly larger (β=.241, se=.055, $p<.001$) in this model than in Model 4, although the standard error was also slightly larger. Similarly, the estimated negative effect (but also standard error) for Hispanic grantors was slightly larger (β=.263, se=.051, $p<.001$). The estimated intra-class correlation, or proportion of unexplained variance attributable to the tract-level clustering, here (ICC=.694, se=.020) was nearly identical to that of the block-group-clustered Model 4 (ICC=.687, se=.015).

In addition, I limited analysis to only the subsample of Barnett shale leases with their geographical centers located within one of the four "core" Barnett shale counties: Denton, Johnson, Tarrant, and Wise counties. These four counties, which together contain 74,174 of the 88,292 lease observations in the main sample, saw the most leasing activity because the shale geology beneath them is most conducive to profitable drilling for oil and gas firms. Limiting the dataset to this subsample did not substantively change the results reported in Table 4.5. The direction and size of the effects for the full model were nearly identical between the two samples, with the only noteworthy difference in the coefficients being that the size of the positive effect for the control of instrument date was even greater for this reduced subsample. The estimated intra-class correlation was also lower for the full model in this subsample (ICC=.532, se=024) compared to that of the full Model 4 in the main sample (ICC=.687, se=.015), meaning that, for this subsample, there is less correlation in observations within the same neighborhood cluster compared to that of the main sample. In other words, the proportion of the total variance in

[50] In the interest of space, and because the results are nearly identical, I discuss only the most relevant findings here. Full results available upon request.

royalty accounted for by the clustering is lower for this subsample, which is to be expected given that clusters in this subsample should be more alike geologically. All three of these alternative analyses for the Barnett shale add further support to the conclusion that local networks and social capital historically disadvantaged racial minorities may be receiving lower payouts.

Finally, it is worth briefly discussing possible interaction effects between local ties and race. I note at the outset here that an examination of the Bayesian Information Criterion (BIC) (Schwarz 1978) model-selection statistic reveals that Model 4 (Table 4.5) is a more parsimonious fit to the data (log pseudolikelihood=-172560.94, df=8, BIC= 345247.15) than a model that adds interactions of local grantor and the grantor-race dummies (log pseudolikelihood=-172553.9, df=11, BIC= 345267.24). I therefore discuss it in this section and do not include it in the main table of estimates (Table 4.5). Here, adding the interactions to the model did not change the direction or significance of the control variables or the main effect for local grantor (β=.262, se=.058, $p<.001$). For each grantor-race predictor, however, the magnitude of the estimated negative main effect from Model 4 was reduced such that I cannot reject the null that grantor race has a significant independent effect on royalty outcomes (Black: β=-.079, se=.134, p=.553; Hispanic: β=.001, se=.118, p=.993; Other: β=.095, se=.146, p=0.516). Similarly, none of the interaction effects were sufficiently significant to reject the null of no effect (local*Black: β=-.226, se=.159, p=.154; local*Hispanic: β=-.226, se=.124, p=.068; local*Other: β=-.170, se=.154, p=.271). However, it worth looking into the estimated interaction effects a bit further.

The interactions were all in the negative direction, suggesting that, all else equal, the estimated negative effect on royalty outcomes of changing from white to minority race is more pronounced for local-resident, racial-minority grantors than it is for non-local, racial minority-grantors Alternatively, they could suggest that the estimated positive effect on royalty outcomes for local residents is attenuated for local-resident racial-minority grantors compared to local-resident white grantors. Nevertheless, the differences between the predicted main race effects and the predicted interaction effects warrant more investigation and additional research, as they could be generative of new theoretical insights into differential effects of local-community ties for whites compared to people of color in negotiated transactions, at least in the case of fracking development in the Barnett.

4.6 Conclusion

To summarize, after analyzing a unique proprietary dataset of nearly 90,000 mineral-rights lease contracts negotiated between individuals and energy firms at the height of the fracking boom in Texas's Barnett shale, my findings reveal that people of color, in particular those of Hispanic/Latino ethnicity, received lower bargained-for royalty outcomes than white leaseholders, all else equal. In addition, I found that those who live within the same county as their mineral-rights tract receive a significant boost in expected royalty payout, net of other factors.

My findings suggest that social inequalities that negatively affect people of color in other social spheres, spill over to people of color when negotiating over property rights and get reinforced in binding, legal instruments like mineral-rights lease contracts. This adds to literatures in inequality and economic sociology a new domain, subsurface property rights, in which social categories such as race become reinforced. Leveraging the structure of the US mineral-rights system, in which real property-rights holders may not live on the land over their property, I found support for the hypothesis that contract outcomes favor those who also live in the local area. My findings add evidence to theories from economic sociology that local network ties confer informational benefits and social capital to local sellers when bargaining.

The study has some limitations that future research could attempt to address. First, of course, given the non-random assignment of the various features of leases and grantors that I test here, causal inference is limited. An experimental design, or perhaps an audit study of the kind carried out in studies of market discrimination (e.g., Ayres and Siegelman 1995), would be a useful complement. In addition, qualitative research could supplement the analysis here by gaining a richer understanding of the micro-level dynamics at work during leases negotiations and tease out additional mechanisms to explain the discrepancies beyond community embeddedness and racial biases.

Second, it would be ideal to know grantors' self-identified race/ethnicity, but given the nature of the contractual data, it is not possible. My approach to predict race, which matched grantor addresses to Census blocks, then used that information and grantor surnames to predict race, then kept only those observations predicted at the 90% level of confidence, was reasonable. A future study could use similar methods to predict grantors' genders, or, ideally, could harness other administrative datasets (state voter registration files, for example) to obtain such sociodemographic characteristics. Doing so would enable researchers to examine how the intersectionality of gender and race may contribute to exacerbated (or mitigated) inequalities in negotiated outcomes (see Collins 2000 [1990]).

Another avenue to pursue would be to assess whether these lease outcomes are influenced by "neighborhood effects" (Sampson, Morenoff, and Gannon-Rowley 2002; Sharkey and Faber 2014). This could be particularly interesting, as it could build off of my finding regarding the positive influence of local-community embeddedness. It could also leverage the split-estate property rights legal framework to assess not only the advantages and disadvantages conferred on grantors based on the characteristics of their place of residence (e.g., social class, racial demographic features) but, in those cases where mineral-rights holders do not reside in the same community as the leased location, variation in lease outcomes based on features of the leased area, as well. My supplementary, between-within multilevel analysis (Chapter 4 Appendix, Table A-4.1) was a step in this direction. Such an account would enrich my framework by focusing more squarely on how "spatial logics" (Sampson 2012) organize and mediate interactions around fracking and contribute to spatial inequality (see Lobao et al. 2007). This may be especially pertinent in cases of economic development and natural-resource use like fracking, given their inherent place-based ties to geological and geographical features of the environment.

Limitations notwithstanding, through my examination of how social relations structure contractual terms (and, thus, economic outcomes), I added a new institutional domain—subsurface mineral property rights—to the literatures in economic sociology and inequality and a sociological perspective of contracts as artifacts of inequality to theories of property rights and contracts. More broadly, with my analysis of thousands of mineral-rights leases, I have offered empirically based explanations for why some individuals receive better bargains than others in their negotiations with oil and gas companies, thereby making an important contribution to contemporary issues of economic inequality.

CHAPTER 5

CONCLUSION

Throughout this dissertation, I have explored the socio-legal environment surrounding the innovative but controversial practice of "fracking," which only entered the national consciousness in the last decade but has transformed the United States energy economy and sparked outrage among environmental activists. Likewise, fracking has forced states, many of which had little or no prior experience with oil and gas production, to decide whether and how to regulate fracking. And it has made a particular legal instrument—the mineral-rights lease contract—an important artifact of social processes, generating billions in royalty revenues to individual mineral-rights owners but reinforcing social inequalities in the process. In this concluding chapter, I reflect on the major findings and contributions of my three empirical chapters.

First, I discuss the findings from Chapter 2. The vast majority of contemporary American codified laws are state-level administrative rules and regulations, especially when it comes to governing economic activities in newly opened markets. Despite their importance, however, there are very few sociological studies comparing such regulations (as opposed to statutes), especially over time. In Chapter 2, I drew from theories of social movements, organizations, politics, and markets to examine the role of industry and social movements in whether states decide to refrain from issuing new regulations governing fracking, regulate it, or ban it entirely. Specifically, I analyzed chemical disclosure reporting regulations, which require fracking firms to publicly disclose the potentially toxic chemicals they use in fracking operations. First, consistent with findings from political sociology and social-movement literatures, I found that a) the more economically healthy the state, and b) the higher the environmental movement's organizational capacity in a state, the more likely the state will regulate the fracking industry or ban fracking. Contrary to theoretical expectations, when considered by themselves, an increase in liberal ideology in a state's government was predicted to decrease the odds of regulation, and an increase in resource-dependence by the state's economy on the oil and gas industry had no significant predicted effect. The most interesting finding, however, is that once I interacted these measures with my measure of potential profitability (and accordingly, potential risk) in the state, the effects were in line with theoretical expectations. These findings suggest that 1) more ideologically liberal states may not exhibit the expected effects of increased industry oversight until the threat of environmental and health risks become a salient issue and 2) states heavily dependent on the oil-gas industry should expect industry to exert more influence on regulation as the economic stakes for industry become higher.

Unlike most studies case-based studies of political/legal mobilization, in this chapter, I simultaneously tested influences of social movements, industry, and political culture on state economic regulation, rather than focusing on one or the other. I also departed from conventional accounts by analyzing how the effects of these factors vary depending on how potentially profitable (and risky) industrial development could be. In these situations, in which the stakes are raised, a state's dependency on the industry to be regulated increases its vulnerability to regulatory capture. On the other hand, it is also during these situations that a government's partisan ideology is more likely to affect its decision to intervene in the market.

In Chapter 3, having qualitatively coded the content of every state's chemical disclosure regulations from 2009 through 2016, I assessed the political, economic, and cultural factors influencing how *stringently* states regulate the economically beneficial but risky industrial activity of fracking. This is a separate issue from the question of whether states regulate fracking. As my findings show, this issue also brings into play interstate—in addition to intra-state—forces affecting regulatory stringency, as a state's expected regulatory stringency for fracking is most influenced by how stringently its geographically proximate peer states regulate fracking. In other words, states tend to converge toward their peers in regulatory stringency. In addition, the interaction of increased economic hardship with increased fossil-fuel industry political influence is associated with less stringent regulation, although neither factor exhibits independent effects. This suggests that in times of crisis, as in my case with states facing pronounced economic hardship, state actors become more susceptible to the allure of material resources from industry donors, which promise to stabilize their positions in exchange for decreased regulatory oversight.

This chapter makes several contributions for scholars in the sociology of law, political sociology, economic sociology, and organizations. First, I argued for a field-theory-based (Fligstein and McAdam 2012) approach to state regulation in federal systems. Such a framework conceives of states as simultaneously 1) occupying their own regulatory fields and thus influenced by intra-state factors such as economic health, industry capture, and 2) embedded within a broader national-level field of regulation, thereby attuned to the regulatory decisions of similarly situated states and subject to isomorphic pressures (DiMaggio and Powell 1983). Second, I departed from conventional accounts in political sociology and policy studies by constructing and analyzing a longitudinal database of state regulatory stringency, rather than simply assessing factors influencing the propensity for a state to pass a statute. Doing so required considerable effort, as it entailed qualitatively coding the content of state regulatory archives in effect at each year. But the additional effort, I argue, is necessary for serious research into today's administrative state, especially in federal systems like that of the United States, where the real legal oversight of industrial activities tends to take place in state-level socio-legal arenas, or what I call regulatory fields.

Finally, in Chapter 4, I shifted from the state to the local level. I also moved from examining forms of top-down, public law—state-level regulations—to a form of private legal ordering—mineral-rights lease contracts, which are negotiated between oil and gas firms and private individual mineral-rights owners. I analyzed a unique proprietary dataset of nearly 90,000 leases in Texas's Barnett shale. First, controlling for other factors, I found that local-community embeddedness yields expected higher payments to mineral-rights owners when compared to those who own the rights to oil and gas located in one community but reside in another. Second, I found that socially disadvantaged people of color, in particular those of Hispanic/Latino ethnicity, receive significantly lower royalty payouts when compared to whites, all else equal. These findings of racial disparities extend to black leaseholders when analyzing a dataset of leases for areas of fracking across the entire country, although more research is needed to substantiate the national-level findings.

I explain my findings regarding lease payout disparities by drawing from theories of economic sociology and inequality. Specifically, my findings add support to the theory that local-network ties can confer benefits to those engaging in economic transactions involving imperfect information, as they can open pathways to locally sourced information and bestow social capital that can be beneficial during contract negotiations. Regarding racial disparities, my findings lend support to prior research on discrimination in bargaining and economic exchange, although additional research is needed to isolate the precise mechanisms involved here. Finally, opening a new empirical domain—subsurface property rights—for socio-legal studies of contracts, I answer Suchman's (2003) call for researchers to study how contracts serve as artifacts of broader social processes. The chapter should spur scholars in economic sociology and law & society to build on my research by further theorizing, and demonstrating empirically, how social inequalities can be reinforced in legal instruments in subtle but consequential ways.

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APPENDIX A: Chapter Appendices

Chapter 3 Appendix

Figure A-3.1: Estimated Hazards for Presence of Regulation, 2009-16

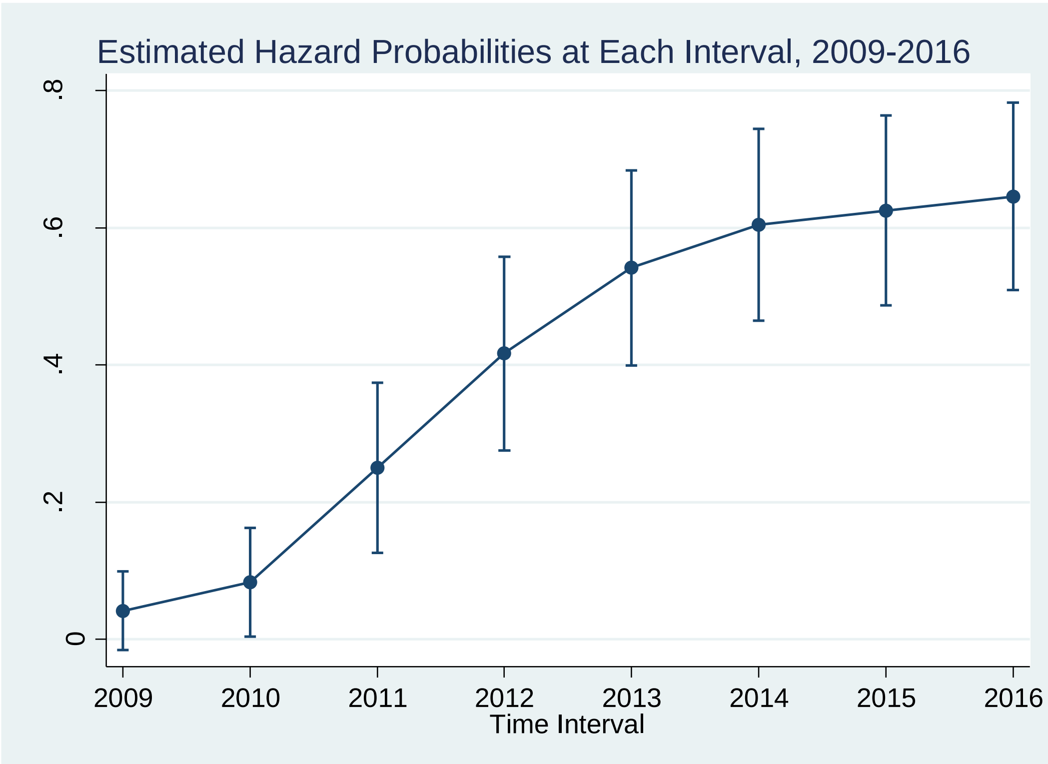
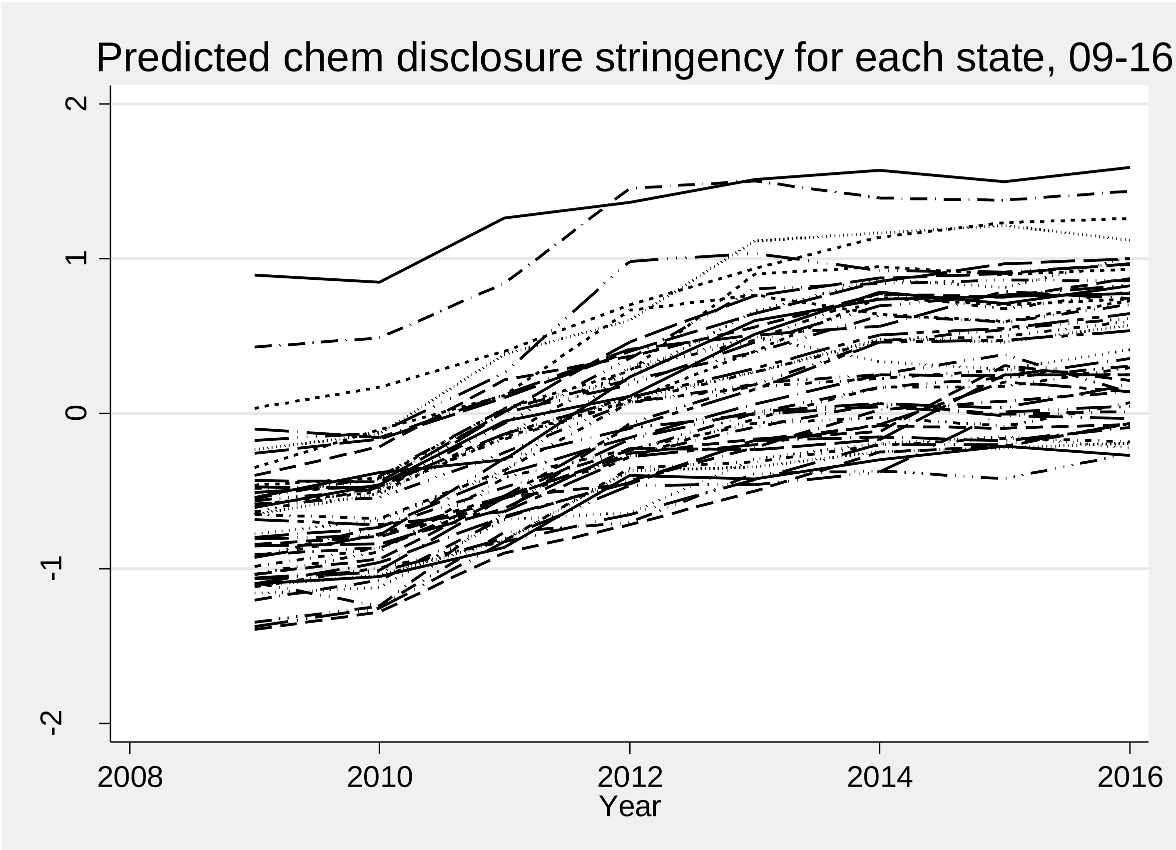


Figure A-3.2: Predicted Regulation Stringency for each State, 2009-2016



Chapter 4 Appendix

Table A-4.1: Influences on Lease Royalties (Barnett Shale, TX), 2006-10

	(1) null	(2) controls	(3) IVs only	(4) full
Fixed Effects (dev. from cluster means)				
local grantor			-0.118*	0.211***
			(0.058)	(0.053)
			-2.04	3.970
grantor race			-0.106***	-0.072***
			(0.022)	(0.017)
			-4.84	-4.278
leased area (logged acres)		0.132***		0.140***
		(0.020)		(0.020)
		6.758		7.005
primary term (months)		-0.030***		-0.030***
		(0.005)		(0.005)
		-5.848		-5.768
gas futures price		0.214***		0.214***
		(0.014)		(0.014)
		14.940		14.984
lease date		0.003***		0.003***
		(0.000)		(0.000)
		16.904		17.203
Random Effects (cluster means)				
local grantor			3.945***	0.500
			(0.284)	(0.416)
			13.89	1.203
grantor race			-0.030	-0.343**
			(0.121)	(0.128)
			-0.25	-2.686
leased area (logged acres)		-0.628***		-0.608***
		(0.038)		(0.059)
		-16.665		-10.340
primary term (months)		-0.058***		-0.050***
		(0.009)		(0.010)
		-6.414		-5.083
gas futures price		0.379***		0.366***
		(0.051)		(0.050)
		7.492		7.282
lease date		0.002***		0.002***
		(0.000)		(0.000)
		6.090		6.094
Constant	22.136***	20.539***	19.048***	20.357***
	(0.075)	(0.693)	(0.246)	(0.803)
	296.463	29.649	77.48	25.355
Observations	88,292	88,292	88,292	88,292
Number of groups	1,119	1,119	1,119	1,119
Est. method	MLE	MLE	MLE	MLE
Varying intercept	YES	YES	Lease	YES
Residual-error structure	independent	independent	independent	independent
Cluster robust SEs	YES	YES	YES	YES
n parameters	3	11	7	15
log-likelihood	-182843	-172382	-182657	-172295
model deg. of freedom		8	4	12
chi-squared (Wald)		1152	255.3	1373
intra-class correlation (ICC)	.622	.547	.569	.545
ICC std error	(.016)	(.022)	(.020)	(.022)

Robust standard errors in parentheses
z-statistic below robust standard errors
*** p<0.001, ** p<0.01, * p<0.05

APPENDIX B: IRB Approval Letter, Committee for Protection of Human Subjects

UNIVERSITY OF CALIFORNIA AT BERKELEY

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COMMITTEE FOR PROTECTION OF HUMAN SUBJECTS
OFFICE FOR THE PROTECTION OF HUMAN SUBJECTS
University of California, Berkeley
2150 Shattuck Avenue, Suite 313
Berkeley, CA 94704 -5940

(510) 642-7461
Fax: (510) 643-6272
Website: http://cphs.berkeley.edu
FWA#00006252

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	*April 27, 2015*
TO:	*Neil D FLIGSTEIN, Socio*
	Daniel Kluttz, Socio
CPHS PROTOCOL NUMBER:	*2015-02-7207*
CPHS PROTOCOL TITLE:	*The Social Determinants and Consequences of Hydraulic Fracturing Regulations and Mineral-Rights Contracts"*
FUNDING SOURCE(S):	*NONE*

A(n) *new* application was submitted for the above-referenced protocol. The Committee for Protection of Human Subjects (CPHS) has reviewed and approved the application on an expedited basis, under Category *7* of the federal regulations.

Effective Date: *April 27, 2015*
Expiration Date: *April 26, 2018*

Continuation/Renewal: Applications for continuation review should be submitted no later than 6 weeks prior to the expiration date of the current approval. *Note: It is the responsibility of the Principal Investigator to submit for renewed approval in a timely manner. If approval expires, all research activity (including data analysis) must cease until re-approval from CPHS has been received.* See Renew (Continue) an Approved Protocol.

Amendments/Modifications: Any change in the design, conduct, or key personnel of this research must be approved by the CPHS ***prior*** to implementation. For more information, see Amend/Modify an Approved Protocol.

Three-year approvals: Minimal risk, non-federally funded protocols that are not subject to federal oversight may now be given a three-year approval period. Please see Three Year Approvals for information about which protocols can qualify for three-year approvals.

The addition of federal funding or certain modifications that increase the level of risk may require a continuing review form to be submitted and approved in order for the protocol to continue. If one or more of the following changes occur, a Continuing Review application must be submitted and approved in order for the protocol to continue.
• Changes in study procedures that increase risk;
• Addition of federal funds.

Unanticipated Problems and Adverse Events: If any study subject experiences an unanticipated problem involving risks to subjects or others, and/or a serious adverse event, the CPHS must be informed *promptly.* For more information on definitions and reporting requirements related to this topic, see Adverse Event and Unanticipated Problem Reporting.

This approval is issued under University of California, Berkeley Federalwide Assurance #00006252.

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If you have any questions about this matter, please contact the OPHS staff at 642-7461 or email ophs@berkeley.edu .

Sincerely,

Jane MAULDON
Committee for Protection of Human Subjects